THE

# ELECTRICAL REVIEW.

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THE

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## ENGINE POWER AND SELF-PROPELLING VEHICLES.

WE have always understood that when James Watt invented the modern horse-power of 33,000 foot-pounds per minute, he did so, having found from experiment that a horse could perform about 22,000 foot-pounds, and he added 50 per cent. so as to stop any grumbling on the part of his clients. From an article by Sir David Salomons in the *Engineer* of June 19th, it would appear almost as though a mechanical horse-power was a very poor affair. For a vehicle weighing 2½ tons, Sir David asks for no less than 20 horse-power in order that the vehicle may travel up a 10 per cent. hill at a speed of 7½ miles per hour. We trust that Sir David is not to be classed with the "scorchers," and we think he is inclined to take too low an estimate of what can be effected. He goes on to say that no vehicle will be of much service for heavy work, unless it possesses an engine equal on occasion to 30 H.P., and that for light traffic a carriage must work up to 12 horse-power. Now, we are inclined to ask are these so-called light carriages so very much heavier than an ordinary horsed vehicle that they require motors of 12 horse-power. We seem to remember occasions when we have driven in four place vehicles with one horse only, without rendering ourselves in any degree liable to prosecution by the ubiquitous S.P.C.A. Double the weight of the vehicle to allow for the motor, and nothing like 12 horse-power can be made out. The truth is that though the horseless vehicle is so young, it is being already grumbled at that it will not run up hill at 15 miles per hour. Surely the men who have used their one-horse traps will be content, as of old, to still run up hill at a less speed. There is a very steep hill at the Crystal Palace from the running ground to the stabling shed. Yet a gasolene vehicle moved up that hill at a fast walk, and we think too much is being made of the slower up-hill speeds, and that if insisted on a demand for large horse-powers will put a great check on the motor carriage industry. That a few years will probably see them vastly improved is most likely, and they are sure to be much used as soon as it is legal to do so. With benzolene at probably 6d. a gallon, and a consumption of even so much as one gallon per hour, the cost to a man alone would not exceed ½d. per mile, and this, too, for a four-place vehicle of 15 or 16 cwt. Yet Sir David speaks of 2½ tons, which seems to be quite in excess of what is the case. Possibly he has in view vehicles of a much heavier type than we have seen, and, perhaps, intended for parcel traffic. But Sir David is in favour of steam in the form, we conclude, of the Serpollet engine. We have nothing to say against the Serpollet motor. It is extremely interesting and ingenious, and as we have lately seen it in Paris on the tramways, it works exceedingly well, but the Serpollet motor is, we should say, only suitable for use on tramways, or on vehicles which are necessarily large, and carry large loads, and are in such number as to enable skilled mechanics

to be employed to look after them. The Serpollet boiler is what we would term a boiler for distilled water. It is apt to choke with hard water, and the tubes may have to be cleaned by dilute hydrochloric acid. But who is to employ this method? It may be easily done in the running shed, but private owners would find it difficult. The *Engineer* devotes an editorial to the Crystal Palace Exhibition, and girds at all motor vehicles. True, they have their faults, are far from perfect, may sometimes refuse to start from some fault with the ignition; but here, again, we are supposed to acknowledge that the horse is perfect. Does not even a horse jib at times, and waste 10 or 20 minutes in starting; and, moreover, when a horse refuses to work, it is at times apt to go through very dangerous foot exercise? The jibbing motor has no fault other than jibbing. As regards our contemporary's contention that motor vehicles will not reverse except at great complication, we unhesitatingly say that this is not the case. There is no motor vehicle that can equal the electrically-propelled one in ease of reversal; but it is far simpler and easier to reverse a benzolene carriage than to back a horse down a street, and it is easier to turn the motor carriage in a narrow space than to get a long horse and vehicle round. Granting all that our contemporary says of poor workmanship on foreign-built vehicles, is there not all the more reason to believe that if these badly constructed carriages do so well in France, we, in England, with better workmanship, will be able to do very much better, even without any great departure from the French type. Now in France, motor carriages are becoming common. They do not attract special attention in the streets. Small boys do not tender their advice as to getting inside, and generally they are accepted facts, which are in process of daily improvement. We are not prepared to say that the accumulator battery is yet in such a state as to warrant its use on vehicles outside city limits. But there can be no doubt that the gasolene vehicle is already fit for country work, and that if it comes into general use, it will pave the way for electricity, just as soon as electricity is ready to avail itself of the opportunity. But electricity will never go forward on the strength of statements published in a prospectus that the motor weighs only 62 lbs. per horse-power. This is distinctly misleading unless reference is made to the great weight of the battery to be carried to work the motor. Once let a reasonable Act pass the Legislature, and we feel sure that the demand for motor vehicles will be fairly met, and also that though makers first in the field will be making quite a different vehicle in a few years' time, they will reap the advantage of an early start.

---

Moore's Vacuum Tube Light.

THE great advance made by Mr. Moore in the production of light by vacuum tubes, which we commented on recently in the ELECTRICAL REVIEW, has naturally led electricians to inquire as to the efficiency of this system when compared with the incandescent lamp. Certain tests have been made in America as to the watts required to excite the tubes with which Mr. Moore lighted the hall of the American Institute of Electrical Engineers on the occasion of his paper being read. Direct measurements were made by Mr. Wetzler of the watts in the vacuum tube circuit, and indirect measurements were made by Prof. Anthony and others of the watts consumed by the motor used to drive the generator. The latter method was adopted to eliminate any error which might result from the instruments used by Mr. Wetzler not being adapted to measure the rapidly alternating currents in the tube circuit. The results obtained by the two methods agreed very closely. It was found that a vacuum tube $7\frac{1}{2}$ feet long and $1\frac{3}{4}$ in diameter, required about 50 watts to excite it to full brilliancy. No exact data as to the candle-power of such a tube have yet been forthcoming. We can only judge approximately as to this by some remarks by Prof. Anthony, that he could not read so easily by one of Moore's tubes as by a 16-candle glow lamp, both being at the same distance. From this it would appear that a Moore tube requires about the same watts as a 16-candle lamp, and does not give quite so much light. Spectroscopic observations made by Mr. Nelson Perry have shown that the Moore light contains an excess of violet rays; therefore, we can form no estimate of the illuminating power of these tubes from their photographic effect. Our estimate of the commercial value of this light must necessarily be delayed till exact data are given of the candle-power developed for the electric power supplied. It seems to us that this piecemeal publication of tests do more harm than good to a new invention.

---

Edison's Luminescent Lamp.

MR. EDISON has furnished to a representative of our American contemporary, *Electricity*, some interesting particulars as to the performance of his new lamp, in which light is produced by the impact of the cathode rays upon a phosphorescent material on the inner wall of the vacuum tube. The lamp shown by Mr. Edison was giving, he said, about 2 candle-power. He had run it up higher, but was afraid to do so, as it was the only good tube he now had. He was having some larger ones made which he expected would give about 10 candle-power. Asked as to the energy consumed, he said he had placed a Weston ammeter and voltmeter in the primary of the induction coil, and the readings were 2 amperes and $\frac{3}{10}$ths of a volt. This would indicate only $\frac{3}{10}$ths of a watt per candle-power, which is an extraordinary efficiency when we consider that 3 watts are a good efficiency for the incandescent lamp, and $\frac{1}{2}$ watt for the arc lamp. Edison evidently thinks something better than the induction coil is required to excite his new lamp, for when asked by the reporter, "How about that?" "Oh," said Edison, "that's rotten. This part" (pointing to the tube) "is all right." Though we wish Mr. Edison every success, and believe he is as likely to succeed as anybody, it looks, from what we know at present, that the tube will ultimately be consigned to the same limbo as the coil.

---

Curve Tracer for Alternating Currents.

HERR FRIEDRICH DRENLER describes (*Zeit. f. Elektrotechnik*, xiv., p. 237) an instrument which he has invented for tracing the form of current undulations in alternators. He considers that his apparatus is a considerable simplification of the apparatus proposed by Dr. Fleming, and also of the more elaborate apparatus of Barr, Beckit-Burnie and Rodgers (ELECTRICAL REVIEW, September 27th, 1895). His instrument is, however, similar in principle to the aforesaid instruments, the improvement being in the mechanism, and in the fact that it writes its own record. An insulating disc with a single contact is driven by an electromotor, which may be actuated by alternating current, direct current, or three-phase current, but always so that its period is slightly less than that of the current wave to be traced. The contact piece thus throws a ballistic galvanometer into circuit at a number of equidistant points along the current wave. The galvanometer used is of the D'Arsonval type, which is almost free from self-induction, and has a comparatively strong torsion couple. The device adopted by Drenler to record the deviations is ingenious and novel. A photographic plate is mounted on a conducting table, which is moved forward at a uniform rate by clockwork. Over the photographic plate swings the galvanometer pointer, which consists of a rather long, horizontally swinging strip of paper upon which a strip of tinfoil is pasted. The point of the pointer is bent downwards, and swings quite free a short distance above the gelatine side of the photographic plate. The pointer is connected with the negative terminal of an induction coil, and the table supporting the plate with the positive terminal, and by this means a stream of sparks is discharged on the plate so as to leave a continuous trace of the deviations of the galvanometer.

## THE LANGDON-DAVIES SELF-STARTING MONO-PHASE INDUCTION MOTOR.

Many attempts have been made to produce a self-starting motor to run on an ordinary single-phase alternating current circuit, but most have been characterised by so complex a starting arrangement that they have begun and ended in an experimental laboratory. Possessing low efficiency and small power factor, their adoption would be ruinous alike to supply companies and consumers, and having usually but small starting torque, they are unsuited to most of the uses to which motors are put.

We have had brought before our notice a new type of monophase induction motor, in which the above-mentioned disadvantages are, to a great extent, remedied.

The particulars of the inventions due to Mr. W. Langdon Davies are given in the patent specifications, No. 19,364, 1894, and No. 18,870, 1895. There is little or no change in the rotor, but the method of winding the stator is a decided advance upon previous methods.

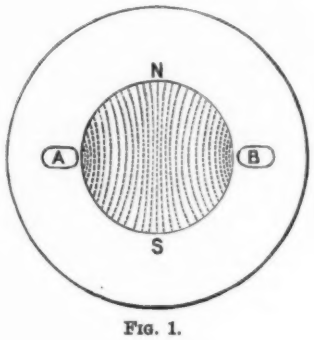



Fig. 1.

Like other inventors, Mr. Davies realises that to make an induction motor self-starting a rotating magnetic field is necessary, and his improvements have replaced the old complex starting arrangements, with its self-induction and condensers, by a simple resistance.

That an induction motor should run steadily and evenly, it is requisite that the magnetic field in which the rotor revolves should be of uniform strength. Any variation in field strength will produce a variation in the E.M.F. induced in the rotor coils with a consequent variation in the torque. The peculiarity of the Langdon-Davies motor is the production of a magnetic field of uniform strength by a suitable disposition of the stator coils. In both rotor and stator the

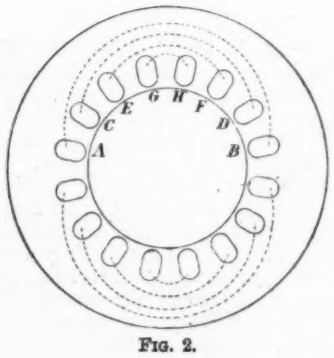



Fig. 2.

copper conductors are imbedded in the iron, so as to enable the air gap to be made as small as possible. The rotor has the usual squirrel cage winding, whilst the stator is *drum* wound.

If the stator were wound simply with conductors down through A (fig. 1), and up through B, the magnetic field would not be uniform, but the lines of force would be densest near A and B, and would diminish to a minimum along N S. This is because the magnetic reluctance along the path, N S, is a maximum. Now, the magnetic induction along any path is directly proportional to the ampere-turns round the path, and inversely proportional to the magnetic reluctance. In order that the magnetic field may be uniform, it follows that the ampere-turns round any path must be proportional to its magnetic reluctance.

Mr. Davies's method of accomplishing this is explained by reference to figs. 2 and 3. A number of equi-distant slots, A, C, E, &c., are punched in the stator stampings. The stator windings are graphically represented by the dotted lines in fig. 2. In fig. 3 the letters, A, C, E, &c., are equi-distant. The radii, 01 and 05, are at right angles, whilst the angles, 102, 203, 304, and 405, are all equal to $\theta$, say. The lines, 4—9, 3—8, &c., are parallel to the radius 0—1, whilst the lines 2—6, 3—7, 4—8, are parallel to 0—5.

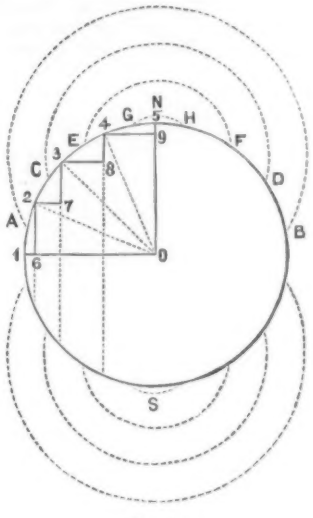



Fig. 3.

It is evident from fig. 3, then, that the magnetic reluctance along the paths 2—6, 3—7, 4—8, are approximately proportional to sin $\theta$, sin $2\theta$, sin $3\theta$, sin $4\theta$, respectively.

[In the particular case of fig. 3, $4\theta = 90°$.]

From this it at once follows that the number of windings through A, C, E, G, should be respectively proportional to the lengths of the lines 2—6, 3—7, 4—8, and 5—9. This is Mr. Davies's rule for the winding of the stator coils in order to produce a uniform magnetic field. Thus, for example, if in fig. 2 we wind 19 turns through A B, then the number of turns through C D, E F, and G H, should be respectively 16, 10, and 5.

The same effect might be obtained by having an equal number of turns in each winding, but by spacing the slots unequally as in fig. 4.

Mr. Davies's motors start as rotary magnetic field motors, and when run up to speed the starting coil is cut out of the circuit. To produce the rotating field, another set of windings is necessary. It is the method of arranging this second set which distinguishes these motors from previous inventions. Like the first set, they are arranged amongst themselves to produce a uniform magnetic field. The number of turns in the two sets is not necessarily the same—in fact, it is usually different—but their *ampere turns* are identical, so that the *uniform fields* due to the two sets of windings *are of the same strength.*

In the construction of the motor the running coils are first wound; these should have as little resistance as possible. The lag, $\theta$, of the current behind the impressed potential difference is then determined by experiment. Let $\phi$ be the desired difference of phase of the currents in the running coil and the starting coil, then the lag, $\psi$, which the current in the starting coil should have behind the impressed potential difference is given by

$$\psi = \theta - \phi.$$

The details of the starting coil are then calculated by means of the formulæ

$$T = a \sin \psi \qquad (1)$$

$$R = \frac{E\, a \sin \psi \cos \psi}{z} \qquad (2)$$

$$C = \frac{z}{a \sin \psi} \qquad (3)$$

Where T = number of turns in starting coils,
R = their resistance,
C = the virtual value of the current flowing in them,
$z$ = total ampere turns determined from the previously wound running coils,
E = the virtual applied potential difference,
and $a$ = a constant.

The size of wire to be used in the starting coils is estimated by the help of equation (3), and its resistance is finally adjusted to suit equation (2) by the addition of a non-inductive resistance placed in series with it.

The starting and running coils are thus each wound so as to produce equal uniform fields in the central space of the stator. To produce the best effect as to starting torque, that is, in order that the starting torque may be at the same time steady, and as large as possible, these two magnetic fields should combine to give a field of uniform strength rotating with uniform angular velocity. Mr. Davies finds that this can only be effected by the fields being inclined to each other at an angle which is the supplement of the phase difference, $\psi$, between the currents in the two coils.* This is the essence of specification 18,870.

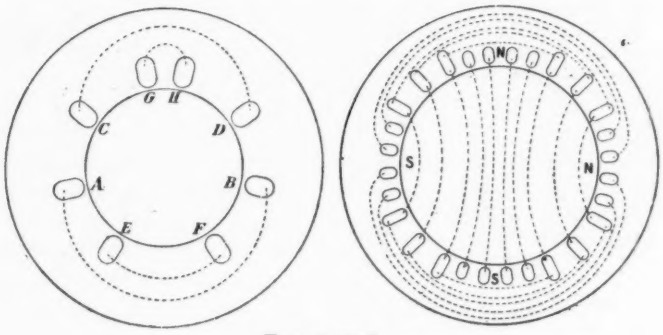
To obtain a uniform field rotating with uniform angular velocity, we must combine *two uniform fields of equal strength* inclined to each other at a particular angle, depending upon the phase difference of the currents producing them.

The starting coil may be wound in some, or all, of the slots which the windings of the running coil occupy, as graphically shown in figs. 5 and 6. The dotted lines indicate the directions of the windings. To produce a uniform rotating field, the coils of fig. 5 should be supplied with currents in quadrature, whilst their difference of phase for the coils of fig. 6 should be 45°.

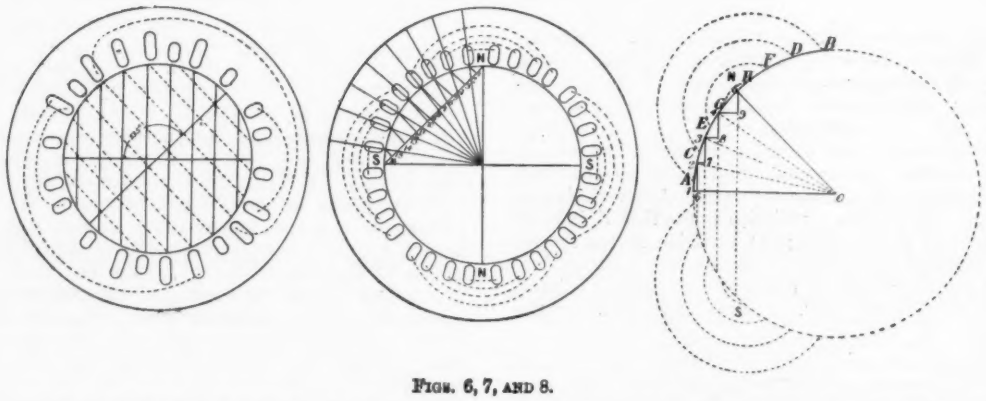
We have hitherto confined our attention to bi-polar machines. Multipolar machines can, of course, be wound on the same principles. Fig. 7 shows the method of winding a four-pole stator, while fig. 8 corresponds to fig. 3, and shows how to determine the number of turns to be threaded through the respective slots. The number of turns through A, C, E and G, are thus respectively proportional to the lengths of the lines 2—6, 3—7, 4—8, and 5—9 in fig. 8.

The rotor, as we have said, is of the squirrel-cage type, and is shown in figs. 9, 10 and 11. It consists of a series of iron discs threaded upon a shaft, A, and clamped fast between screw nuts, B. A feather, C, prevents the discs from turning on the shaft. A series of copper rods, D, are passed through the discs, and at their ends are fixed into massive copper rings, E. Saw cuts are made in the edges of the discs, parallel to the axis, and penetrating into the holes which receive the copper rods. These slits are seen in fig. 11. The thick black lines in fig. 9 represent insulating material. The numbers of slots in the stator, and copper bars in the rotor, are prime to each other. The greatest torque is obtained when the number of the bars in the rotor is the greatest prime number, which is *less* than the number of slots in the stator. Thus if there are 20 slots in the stator, the number of bars in the rotor is 19. Similarly a 32 slot stator should have a 31 bar rotor.

Two of Mr. Davies's motors have been submitted to Prof. S. P. Thompson, F.R.S., to be tested. They were designed to run upon an ordinary alternating current supply at 100 volts, and a frequency of 83 periods per second. The larger of these motors was of three-quarter horse-power. It was a four-pole machine, weighing 125 lbs.




FIGS. 4 AND 5.




FIGS. 6, 7, AND 8.

* The analytical proof of this is as follows:—

Let B be the maximum strengths of the two uniform and equal fields,
„ $\psi$ be their difference of phase,
„ $\beta$ be the angle between the direction of the two fields.

The corresponding instantaneous field strengths will be

$$B \sin p\,t \text{ and } B \sin (p\,t - \psi),$$

and the strength, R, of the resultant field will be given by

$$R^2 = B^2 \{\sin^2 p\,t + \sin^2 (p\,t - \psi) + 2 \sin p\,t \sin (p\,t - \psi) \cos \beta\}$$
$$= B^2 \{1 + \cos \psi \cos \beta - \cos \psi \cos (2\,p\,t - \psi) - \cos \beta \cos (2\,p\,t - \psi)\},$$

which is independent of $t$, if

$$\cos \psi = -\cos \beta$$

that is

$$\beta = \pi - \psi.$$

The following table gives the details of Prof. Thompson's test of this motor.

From these figures the curves connecting brake horse-power and speed, brake horse-power and efficiency, brake horse-power and power factor, have been plotted, and are given by figs. 12, 13 and 14, respectively.

| Brake load (pounds). | Speed. | B. power. H.P. | B. power + correction. H.P. | Torque (pound feet). | Volts. | Amp. | Amp. reading | Apparent power (watts). | Watt meter reading | True power (watts). | True power (E.H.P) | Power factor. | Efficiency. Per ct. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brake unconnected ... | 2,552 | ... | ... | ... | 99·5 | 8.4 | 6·5 | 819 | 4 | 161 | ·21 | ·19 | ... | Speed of field, 2,563. |
| Friction of brake bearing and coupling only... ... | 2,369 | ... | ... | ... | 100·3 | 9·2 | 8·0 | 924·5 | 6·75 | 271·7 | ·36 | ·29 | ... | ∴ Slip at zero load 1½ per cent. |
| | 2,361 | ... | ... | ... | 100·1 | 9·5 | 8·5 | 951·3 | 6·75 | 271·7 | ·36 | ·28 | ... | |
| 2 | 2,540 | ·246 | ·394 | ·508 | 99·75 | 9·5 | 8·5 | 948 | 10·0 | 402·5 | ·54 | ·42 | 73 | |
| | 2,500 | ·241 | ·389 | | 98·75 | 9·2 | 8·0 | 910 | 9·5 | 382·4 | ·51 | ·42 | 76·3 | |
| 3 | 2,450 | ·355 | ·503 | ·762 | 100·0 | 10·3 | 10·0 | 1,030 | 10·0 | 402·5 | ·54 | ·39 | 93·1 | |
| | 2,330 | ·338 | ·486 | | 100·5 | 9·8 | 9·0 | 982·6 | 9·5 | 382·4 | ·512 | ·38 | 91·5 | |
| | 2,330 | ·338 | ·486 | | 100·0 | 10·3 | 10·0 | 1,030 | 9·5 | 382·4 | ·512 | ·37 | 91·5 | |
| 4 | 2,270 | ·439 | ·587 | 1·016 | 99·75 | 11·5 | 12·5 | 1,149 | 12·5 | 503·1 | ·674 | ·44 | 94·2 | Speed of field 2,409, slip at ¾ load ∴ about 5½ per cent. |
| | 2,280 | ·441 | ·589 | | 99·0 | 11·75 | 13·0 | 1,163 | 12·5 | 503·1 | ·674 | ·43 | 94·3 | |
| 5 | 2,310 | ·558 | ·706 | 1·270 | 99·5 | 11·9 | 13·5 | 1,191 | 13·5 | 543·4 | ·728 | ·45 | 96·9 | Considerable vibration of brake. |
| | 2,315 | ·559 | ·707 | | 99·0 | 12·2 | 14·0 | 1,207 | 14·0 | 563·5 | ·755 | ·46 | 93·6 | |
| 6 | 2,287 | ·663 | ·811 | 1·524 | 99·5 | 14·2 | 19 | 1,414 | 15·5 | 623·8 | ·836 | ·44 | 95·9 | |
| | 2,280 | ·662 | ·810 | | 99·25 | 14·2 | 19 | 1,410 | 15·5 | 623·8 | ·836 | ·44 | 95·9 | |
| 6·5 | 2,258 | ·709 | ·857 | 1·651 | 99·5 | 15·6 | 23·0 | 1,555 | 17 | 684·2 | ·917 | ·44 | 93·4 | |
| | 2,240 | ·704 | ·852 | | 99·25 | 15·8 | 23·5 | 1,568 | 17 | 684·2 | ·917 | ·43 | 92·9 | |
| | 2,258 | ·709 | ·857 | | 99·5 | 15·5 | 22·5 | 1,533 | 18 | 724·5 | ·971 | ·47 | 88·2 | |
| | 2,252 | ·707 | ·855 | | 99·75 | 15·3 | 22·0 | 1,525 | 17·5 | 704·4 | 944 | ·46 | 90·5 | |
| 7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | Motor pulled up. |

The starting torque in this motor was found to be about half the torque at maximum output.

We have reliable details of a first test of another ¾ horse-power motor. The method of testing in this case consisted in coupling the motor directly with a dynamo, the load on which could be varied at pleasure by means of a variable liquid resistance. The motor was a four-polar machine, and the test was carried out at about 100 volts, the frequency being 83 complete alternations per second.

The drop of speed from no load to full load was slightly over 9 per cent. of the speed running light, this speed being 2,450 revolutions per minute, as determined by a speed counter.

The power factor varied between 0·23 at no load and 0·57 at full load.

The efficiency at full load was 57 per cent.

A group of Langdon Davies motors is given in fig. 15.

To be perfectly fair in criticising an alternating current motor, several details have to be considered.

The following is an extract from Prof. Thompson's report:—

"As will be seen from the accompanying tests, the apparent drop in speed from no load to full load was under 12 per cent.; the real drop was less, as the frequency of the supply had fallen toward the end of the tests. The power given out by the motor was measured by a Raffard brake, adapted to absorb several horse-power. . . . . The high efficiency shown by these tests was confirmed by the general absence of noise and smoothness of running, and by the cool state of the machine at the end of the tests. There was no undue heating in any part; and the rotating part was quite cool."

FIG. 9.

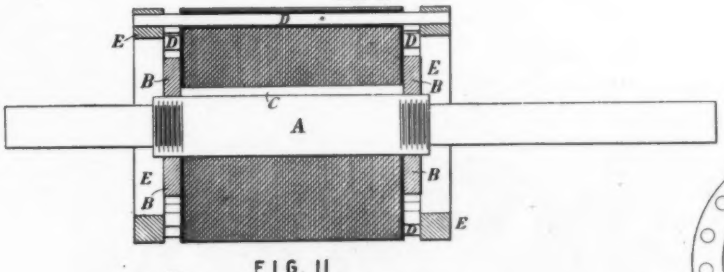



FIG. 11

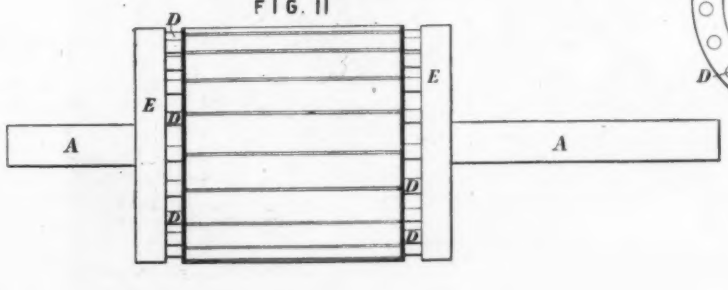
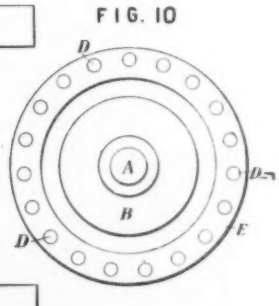



FIG. 10



A first rate motor should simultaneously possess the following qualifications:—

1. Great mechanical strength.
2. Large power factor.

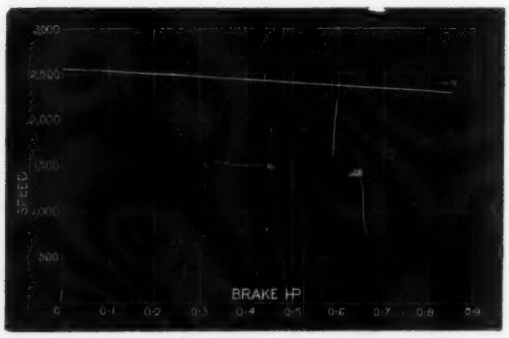



Fig. 12.

Fig. 14.

3. High efficiency.
4. Large and steady starting torque.
5. Small drop in speed between no load and full load.

9. It should get speed up quickly, and should be started by means of a single switch.

In the Langdon-Davies motor all these conditions, except (2), are satisfied to a remarkable degree. We have seen one of these motors, having 32 slots in the stator and a 31 bar rotor, and nominally of about 1 horse-power, start under full load and run up to speed in less than a quarter of a minute; and by gradually raising the impressed volts to their full value by means of an external resistance, the starting torque was rendered perfectly steady.

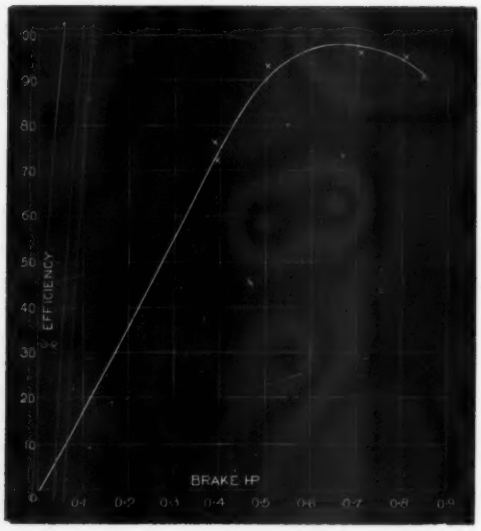



Fig. 13.

The starting arrangement is no more complicated than that of an ordinary direct current shunt motor. There is but one switch; the first position connects the terminals of both starting and running coil with the mains; the second position cuts out the starting coil. When once fixed up, anyone could look after them. The attendant need not have any previous acquaintance with electrical machines.

The current at starting is less than double the current at

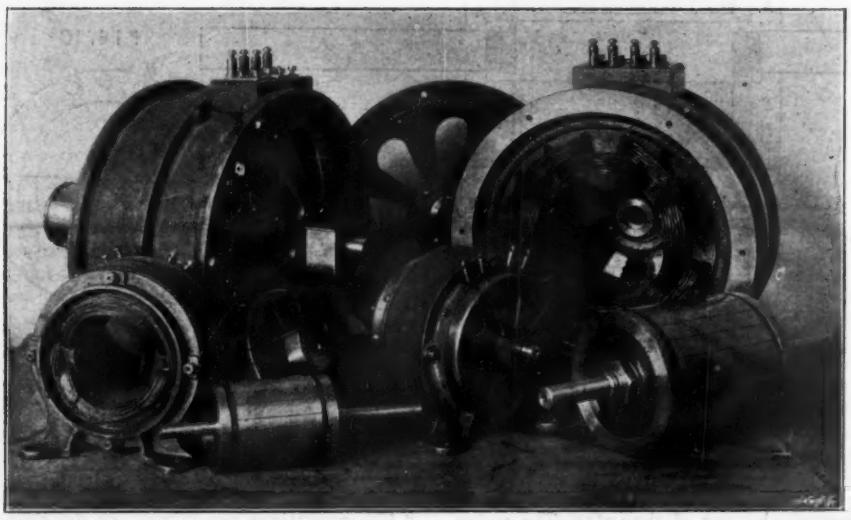


Fig. 15.

6. Not an excessive current at starting.
7. It should not get over-heated, even after running at full load for a considerable time.
8. It should run smoothly, and without jerks.

full load; and notwithstanding their comparatively small power-factor, the motors run exceedingly cool.

It is interesting to compare Prof. Thompson's tests given above with the following data of a three-phase motor of the

same power, taken from his treatise on "Polyphase Electric Currents":—

| | |
|---|---|
| Effective horse-power at the pulley ... ... | ¾ |
| Revolutions per minute at no load ... ... | 1,500 |
| " " " full load ... ... | 1,435 |
| Efficiency at full load (per cent.) ... ... | 68 |
| Power factor ... ... ... ... ... | 0·75 |
| Number of poles ... ... ... ... ... | 4 |
| Current (per branch) at full load (amperes) ... | 3·3 |
| Current (per branch) at starting with tight belt and light load (amperes) ... ... ... | 11 |

By comparison, we see that this shows superiority only as regards constancy of speed and power factor; in other respects it is inferior. From the consumer's point of view, the Langdon Davies motor seems to leave little to be desired; but from the supply companies' point of view the low power factor is a drawback.

We think that certain details of construction which are prejudicial to efficiency and conducive to a higher power factor are deserving of attention, and that a compromise between power factor and efficiency might be effected. A mono-phase motor of ¾ horse-power, having a power factor of 0·75, and an efficiency of 80 per cent., might be produced, instead of one of equal power having a power factor of 0·5 and an efficiency of 95 per cent.

If the supply companies object to the present low power factor, we would suggest a corresponding increase in the price of electrical power for motive purposes until the evil is remedied. The Langdon-Davies motor is so excellent in other respects, and so easy to manage, that consumers will willingly pay a trifle more on being assured that they have now a mono-phase alternating current motor which is not subject to the freaks and indispositions which have hitherto characterised such machines.

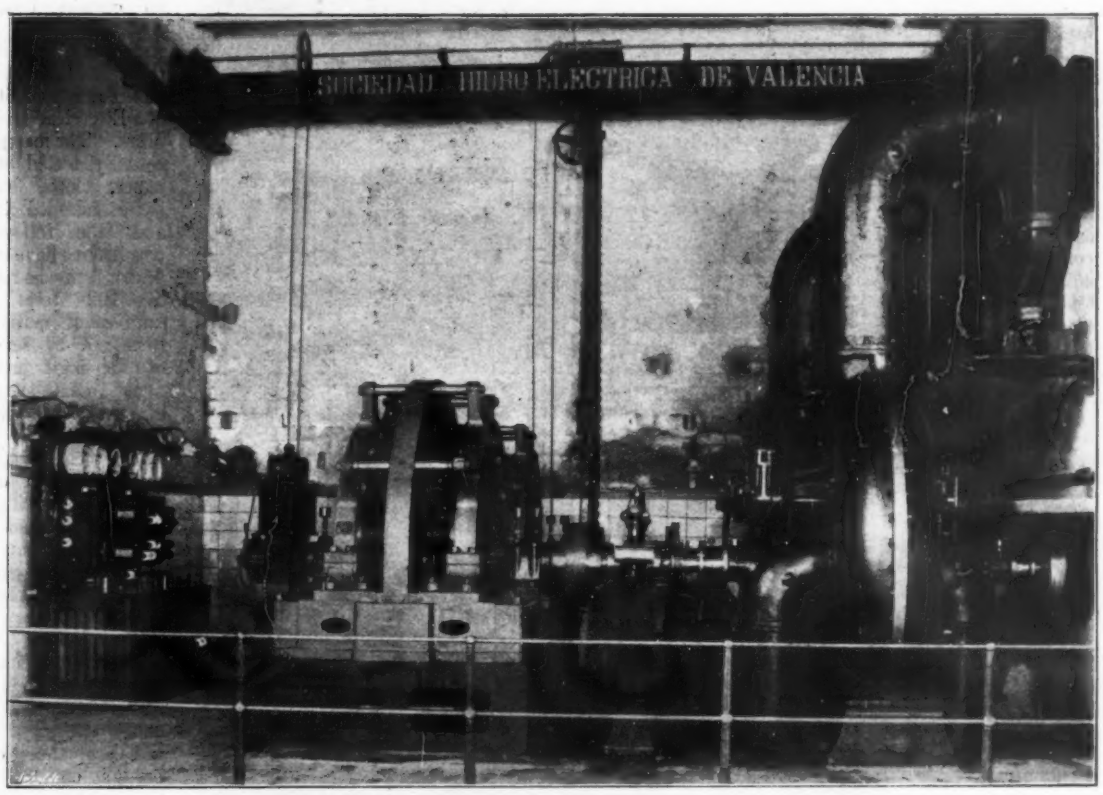
One is always willing to pay more for a thoroughly reliable article.

**The Institution of Electrical Engineers.**—By the kind permission of Major Cardew a small party of students of the Institution will visit the Board of Trade Standardising Laboratory, 8, Richmond Terrace, Whitehall, on Saturday, July 4th, at 11.0 a.m.

## ELECTRICAL TRANSMISSION IN SPAIN.

A recent system which has been put down by Messrs. Siemens Bros. in Spain, is very interesting. The object is to supply light and power to Alcoy and Gandia, two important towns in the province of Valencia.

The power for the above purpose is obtained from the Serpio, a river running between a range of mountains, but having no natural fall. A dam was constructed in a convenient position, and from this point a canal was formed by cutting a step in the mountain side, and building a wall on the outer side, the canal being 2 kilometres in length and 5 square metres in cross section. The water is controlled by gates at the point where the water enters the dam, a bye-pass being provided so that the canal may be emptied at any time. A number of valves are also provided in the canal wall for cleaning purposes, and at the end of the canal near the power-house an overflow is provided, so that all surplus water may run off. Immediately under this a well is formed, 2 metres in diameter, which terminates in a horizontal cast-iron pipe of the same diameter, which is situated inside the power-house, and from which the turbines take water. The effective height of fall is 96 feet, and the minimum quantity of water is 6,000 cubic feet per minute.




Electrical Transmission in Spain.—Interior of Power House.

The power-house is a two-story stone structure 20 metres in length by 10 metres in width, built on the side of the mountain, and is situated nearly equidistant from the two towns to which energy is transmitted, Alcoy being separated from Gandia by a distance of 50 kilometres. On the first floor is placed the generating plant, the second being used as living rooms only.

The turbines are made by G. Gilkes, of Kendal, England, and produce 150 B.H.P. when running at 375 revolutions per minute. They are coupled direct to the alternators, and are bolted to the same cast-iron girders

which support the alternators and form foundations. The shafts of these turbines are horizontal, and the wheels 26 inches in diameter, the speed being controlled by the movement of guide blades, which is effected by a centrifugal governor actuating a hydraulic cylinder. Two sets of generating plant are at present erected, but provision is made for three extension sets. The alternators are of Siemens's standard single-phase type, having a capacity of 110 kw. at a pressure of 6,500 volts, and 50 complete periods per second. The field magnets consist of 16 pairs, and are fixed. There are 16 coils in the armature, the collectors being placed on either side of the armature disc. The exciters are driven direct from the alternator shaft, so that the floor space required is very small.

The station switchboard is composed of two black enamelled slate panels, supported in hard wood frames. The necessary instruments are insulated from the slate by special insulators, and the high tension switches and fuses are protected by partitions of slate. Synchronisers are provided as the alternators and transformers are worked in parallel. A constant pressure of 6,500 volts is maintained by regulating the exciting current. The transmission cables are composed of naked copper stranded, and are carried on large insulators, the inside shed of which dips into oil. They are supported on wooden poles, which also carry telephone wires to connect the generator station with the transformer stations. All the poles have lightning conductors fixed, and lightning arresters are attached to both ends of the cables. The line of cables is entirely over mountains, some of which are 1,300 feet in height. The system was designed for a total loss at full load of 14 per cent.; but owing to variation in the route, this was somewhat increased. The single line of cable from the power-house to Alcoy is 30·7 kilometres in length.

Electrical Transmission in Spain.—Exterior of Power House.

Electrical Transmission in Spain.—Interior of a Transformer Station.

The first step down transformer station at Alcoy was placed some short distance from the town; in consequence of the authorities refusing to allow the high tension current inside the town. In this station are placed five 40-kw. transformers of Siemens standard type, which transform down to 2,000 volts. Switchboards are provided, with the necessary instruments and are similar in all respects to the station switchboard at the power-house. The current is conveyed to a central station in town by overhead insulated wires, and is there transformed from 2,000 to 115 volts for 110 volt lamps. The pressure at the lamps is kept constant by means of a regulator or adjustable choking coils, placed in the 2,000 volt circuit at the first transformer station. Several motors have been fixed up, being supplied by separate cables from this station.

The transmission to Gandia is similar in all respects, with the exception that the transformer station contains only two 30 kw. transformers, and the loss in line is 10 per cent.

All the work was carried out by native labour, under the supervision of Messrs. Siemens Bros. & Co.'s engineer, Mr. W. H. Kingston, to the order of Messrs. Macnaughton Bros., of Valencia and Glasgow.

## EFFECT OF TEMPERATURE ON INSULATING MATERIALS.

A series of interesting tests have recently been made by Messrs. G. F. Sever, A. Monell, and C. L. Perry, and communicated to the American Institute of Electrical Engineers, on the effect of temperature on certain insulating materials, and were described in a paper read before the American Institute of Electrical Engineers. The materials actually tested were paper, cloth, oiled paper and oiled cloth, and the following conclusions have been drawn from the result of 102 tests on samples of materials furnished by several of the most prominent manufacturers of electrical machinery.

The heating apparatus consisted of a glass cylinder 8 inches in diameter and 10 inches high, covered at the top and bottom with asbestos plates. The lower part of this cylinder was occupied by 12 enamel resistance tubes, 5 inches long, and 24 ohms each. The terminals of these were brought out through the asbestos plate. The current in these tubes being controlled by a rheostat, the temperature in the cylinder could be varied at pleasure. An inch above the heating tubes, and supported by an asbestos collar, was a metal plate having holes punched in it to allow the free circulation of air in the cylinder. This plate was connected to one side of a galvanometer.

The insulating material to be tested was wrapped on brass cylinders ¾-inch in diameter and 3 inches long, the insulation not reaching quite to the end of the tube. The insulation was then wound with bare copper wire for a space of 2½ inches. Five tubes so wound were then placed on the metal plate in the cylinder and their terminals brought up through the asbestos cover, and then to a switchboard, in order that any tube might be thrown into the galvanometer circuit. This arrangement made it possible to heat five specimens at one time.

With the above apparatus was used a Thomson high-resistance galvanometer, a megohm box, and a difference of potential of 500 volts.

The thermometer used was of the nitrogen-filled mercurial type, and capable of measuring from 0 to 400° Centigrade.

*Plain Paper.*—40 specimens were tested. After the resistance at the temperature of the air (22° Centigrade) was carefully noted, the temperature was gradually increased (100° in one half hour) and readings taken every 10° up to 80°, and from there on every 20°.

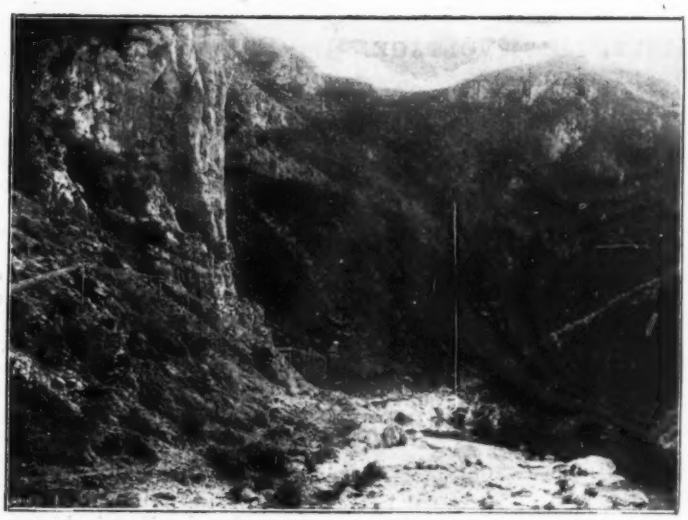
It was found that the resistance of papers that are not protected from moisture falls between 22° and 50°, and then rises rapidly, until at 75° it has attained a maximum resistance. It was also noted that this temperature of 75° is very constant for all kinds of paper. From 75° upward the resistance falls rapidly, and at 150° is but a small fraction of its initial resistance.

The initial resistance of paper protected from moisture by japan is very high, but falls rapidly with the increase of temperature, as is the case of all material protected from moisture. Hence, all paper having a porous structure, and therefore containing more moisture, has a lower initial resistance than the protected paper, but is affected by heat much less than the latter. This would lead to the conclusion that there are two phenomena taking place. First, the driving off of the moisture, which tends to increase the resistance, and secondly, some change (not a mechanical deterioration) in the material dependent on the temperature, and which may be called the temperature coefficient. This temperature coefficient tends to lower the resistance with increase of temperature.

It was seen that the initial resistance of unprotected papers is low on account of the presence of moisture. On gradually increasing the temperature, the resistance falls during the first 20 or 30°, because the effect of the temperature coefficient predominates during this period and before the material is warm enough to start the evaporation of the moisture it contains. This, however, lasts but a short time, as the result of the evaporation is to increase the resistance very rapidly, until, at 75°, the temperature coefficient again asserts itself and the resistance rapidly falls.

In the case of japanned papers, the initial resistance was very high, due to the absence of moisture, but on being heated the resistance dropped rapidly, as the small quantity of water contained evaporated off so slowly that it had very little counteracting effect on the temperature coefficient. Paper does not seem to deteriorate mechanically at less than 180°; above this point the material begins to carbonise. At 230° a peculiar phenomenon takes place. The material, after possessing a very low resistance from 175° upward, would, at about 230°, suddenly increase greatly in resistance and immediately after break down.

*Plain Cloth.*—20 specimens were tested, including canvas, linen, and muslin of different thicknesses. The action of this material is much the same as that of paper. The initial resistance is lower, as it contains more moisture than is the case with paper. For the same reason, when the moisture evaporates off, the increase over the initial resistance is greater than with paper. For cloth, as for paper, the maximum resistance is at 75° Centigrade. The material does not begin to carbonise until at a temperature of 180° Centigrade, and even beyond that point it loses its mechanical strength very slowly until past 220°.



ELECTRICAL TRANSMISSION IN SPAIN.—DISTRICT TRAVERSED BY THE CABLES.

ELECTRICAL TRANSMISSION IN SPAIN.—DISTRICT TRAVERSED BY THE CABLES.

The explanation for the resistance of cloth, varying, as it does, is exactly similar to that for paper.

*Oiled Paper.*—In this class 14 tests were made on papers of different thicknesses. With the single exception of one specimen, the resistance of which was very high, the initial resistance was lower than in the case of paper.

On increasing the temperature the resistance fell rapidly, the curve being much the same as that for japanned paper. The reason for the sudden decrease in resistance is the same as that for japanned paper.

Oiled paper deteriorates mechanically at a lower temperature than paper or cloth, commencing to blacken at so low a temperature as 120° Centigrade.

*Oiled Cloth.*—In this class 28 specimens of oiled silk, muslin, and linen of various thicknesses were tested. The initial resistance of this material is much lower than that of paper, and on increasing the temperature the resistance falls rapidly, as with japanned and oiled paper, the reason for the sudden decrease in resistance undoubtedly being the same as for the japanned and oiled paper. The insulation begins to char at about 120° Centigrade.

*General conclusions.*—*a.* Paper is a better insulation and withstands increase in temperature much better than cloth (shellac and varnish were not used in any of the experiments), oiled paper or oiled cloth.

*b.* Paper and cloth have a maximum resistance when first heated at about 75° Centigrade, and are not injured mechanically under 180° Centigrade.

*c.* The point of maximum resistance for paper and cloth (in this case 75° Centigrade) depends on the rapidity with which the temperature is increased.

*d.* All give a high resistance after cooling, but have little mechanical strength.

Oiled paper and oiled cloth, however, after having been heated to 220° Centigrade, and allowed to cool, not only have a high resistance, but became so firmly fixed to the brass cylinders that is was found necessary to remove them with a file.

*e.* It would be well to bake paper and cloth insulation to 140° Centigrade before applying varnish or shellac.

## ALTERNATING AND DIRECT HIGH VOLTAGE SUPPLY

It was a sign of the times that the first two papers to be submitted at the convention of the Municipal Electrical Association dealt with what is now commonly called high-voltage supply for want of a better designation. The subject has been repeatedly referred to in our columns, and many of the points connected with it have been gone into at length, so that our readers probably feel generally acquainted with the arguments adduced *pro* and *con*. We will, therefore, summarise the remarks of the speakers at the Convention, and place against them the opinions of the writers of the papers, while some further considerations of a general character may be added, in order to put the subject forward in an impartial manner.

### Tendency Towards "High-Voltage."

If one considers for a moment the means provided by municipalities and companies to carry out their obligations under statutory powers, it is evident that there are a very large number of methods, the majority of which, however, differ but in detail amongst themselves. Liverpool is an example of the simple two-wire system, with four stations scattered throughout the city. It, therefore, stands at one end of the line of comparison. At the other one finds Deptford, with its "extra high pressure" of 10,000 volts, and double conversion within the metropolitan area. As a general rule, however, stations can be put into one of two classes; those generating and supplying direct (usually with continuous current) and those which employ converters. Transformer systems, with the one exception of street-converter supply, are now required to adopt sub-stations with a low-pressure distributing network, for the few examples of house transformation that still exist only remain on sufferance, and it is generally understood that the Board of Trade are anxious to do away as soon as possible with transformers in consumers' premises. This desire is supported by the well-known excessive loss that is incurred by the use of a large number of small converters. Therefore, we may classify the systems generally as those which:—

| | |
|---|---|
| Distribute directly to the consumer. | Convert down at sub-stations, each one forming the centre of a distribution area. |

### Choice of a System.

The selection of one or other of the two methods will depend principally upon:—

(*a*) The area of the district to be supplied from one *generating* station.

(*b*) The position of this *generating* station in the area of supply.

In reality we are concerned with the pressure to be maintained on the *distributing mains*, whether these be supplied direct from a generating station or from a sub-station. As a result of this, we find that corporations having three-wire systems are going in for sub-stations for their outlying areas, that others have put in alternating high pressure as well as direct low pressure plant, and that a number of continuous current high pressure systems have been put down, while others are in hand.

Mr. Albert Gay has demonstrated, in an article that appeared in our pages at the commencement of the current year, that there is little to choose so far as financial results go between the different systems. As his conclusions were based upon the *results* of working, they could not be taken to directly apply to what would occur upon developments taking place, first, as to a more general use of electricity throughout the country, and secondly, as to the technical disabilities under which some of the earlier stations are now operating.

The more general complaints are:—

(*a*) Overloaded mains, leading to inability to accept further customers on the same distributors.

(*b*) Imperfect service, such as bad regulation.

(*c*) Low efficiency in distribution.

The doubling of the pressure of supply has been shown to greatly reduce the difficulties under each of these heads.

### (*a*) *Overloaded Mains.*

At present, the distributors in the centre of compulsory areas are, as a rule, fairly well loaded up. It is a costly matter to increase the cross-section of distributors, as the practice is to bury such mains directly in the earth. The ideas that are formed, even by competent authorities, as to the probable demand in the different classes of streets, are often found to be materially different to that actually experienced in after years, and, as a result, mains that, according to their designers, *ought* to be large enough to deal with the load in certain districts, have been found to be totally inadequate.

To paraphrase Mr. Barnard's paper, we would, therefore, say that the relief afforded to already overloaded mains by doubling the pressure throughout, is the most important feature of the use of high voltage lamps. The increased capacity of such mains enables the existing network to be used for a larger demand than had been anticipated, and there is, consequently, an economy in capital outlay. The only alternative is the use of high efficiency low pressure lamps, and as the Electric Lighting Act distinctly forbids any attempt on the part of undertakers to coerce or cajole consumers to use one lamp in preference to another, this solution of the difficulty does not seem a very hopeful one.

### (*b*) *Improved Service.*

The regulation on an overloaded main is necessarily poor, and anything that tends to improve the service, and, therefore, to popularise electricity supply with a better class of customers, is itself a great boon. Coincident with increased capacity of mains is better regulation, as at 200 volts twice as many customers can be supplied on one main, and, at the same time, the percentage drop to the point of lowest pressure will be halved. It is by no means unusual to find that customers connected to a distributor near a feeding point get, say, 104 volts at the time of greatest load, while those farthest away (or midway between two feeding points on a busy thoroughfare) receive only 96 or 97 volts. As Mr. Barnard has pointed out, the important consideration is the percentage difference between the highest and lowest pressure, and when the pressure is doubled on a main the load may be doubled (thus keeping the current the same), but the percentage variation of pressure from the normal or "declared pressure" will be halved.

So much for variations that vary with the increase in steady load, but there are instantaneous variations that are more difficult to deal with. These occur when arc lamps or motors are switched on. Arc lamps requiring normally 10 amperes may take 12 to 14 amperes for some minutes after the arc is first struck, and this sudden increase in current increases the copper drop in the same proportion. Some time ago Mr. Baynes emphasised the importance of reducing what we may call the time rate of change in the load on a station. What may by chance take place is best realised when we mention that the load on a certain English high tension station increased 100 primary amperes per minute for 15 minutes on the occasion of a fog a few months ago. The result may be imagined, and although distribution drop only accounted for part of the consequent reduction in pressure, still the more volts there are to provide for copper losses in the mains, the more readily will a proper pressure be maintained on the lamps. When a motor is switched "on"

or "off" at the end of a rather long main, a jump may be frequently observed on the neighbouring lamps, and the variation at the lamps varies inversely as the square of the supply pressure. Also, in paralleling dynamos, the margin from the proper pressure at which the switch is thrown to put the new machine on the station bars is about 3 volts, and this margin is independent of the actual pressure, so the higher that is the smaller the percentage error.

### (c) *Efficiency.*

When we come to the question of efficiency, the advocates and critics of high voltage fail to see eye-to-eye. There are no high efficiency high voltage lamps on the market as yet. So-called "high efficiency" 100 or 110-volt lamps are advertised and sold, but at the same time are seldom to be found in use. Low candle-power lamps are, so far, impossible with 200 volts, but then they are hardly ever used on 100-volt circuits. The efficiency of 200-volt lamps varies from $3\frac{1}{2}$ to 4 watts per candle-power, and as we showed some time ago in an article on tests of incandescent lamps, the same figures apply to 100-volt lamps. A 16 C.P. 100-volt lamp takes 60 watts, and an 8 C.P. about 35 watts. The best proof of this is furnished by the sum of the readings of Wright-Demand indicators on a large central station, where the current per lamp was carefully worked out, and the equivalent 16-C.P. lamp was found to take two-thirds of an ampere. Wattmeter tests of a bank of 200-volt 16-C.P. lamps, and of another bank of 100-volt lamps of the same C.P., proved that there was very little difference in the power taken to bring the lamps up to normal pressure.

Three-wire systems may find trouble in balancing; some, to our knowledge, know that this essential is by no means easily obtained in actual work, due to the different times in the evening at which current is taken by customers. A two-wire system, possessing the advantages of a three-wire, without this difficulty, and avoiding the use of a patented arrangement of conductors, must find favour, on account of its simplicity. Should the suit for the prolongation of the three-wire patent prove successful, an additional argument will be introduced into the question, and two-wire networks at 200 volts may take the place of three-wire at a lower pressure.

So far we have endeavoured to sum up the arguments used by the speakers at the Convention, who were more or less favourably inclined to high voltage. Before passing on to consider two other heads, we must deal briefly with:—

### (d) *Street Transformer Distribution.*

So far as sub-stations are concerned, the arguments that apply to distribution direct from generating stations are applicable also, as the only difference that a change in pressure need make is to call for an alteration in the winding of transformers or motor-generators. The size need not be different. With street transformers, however, the circumstances point strongly to the benefits of higher pressures. Street transformers are placed in parallel between high and low tension mains. They require some form of street switch-box to be inserted in the high tension main, and involve the placing of a considerable number of boxes in the footway. The sizes of such transformers run from 5 up to 30 kilowatts, 10 and 20 kilowatts being general. The low tension mains fed in this manner have cross-sections of from $\frac{1}{10}$th to $\frac{1}{3}$th of a square inch. Now, the number of transformers in practice is fixed more by the requirement of a reasonable good pressure distribution than by the current load on the distributors. Eight or nine transformers per mile run, say at intervals of 150 to 800 yards, have to be put down to keep the pressure within Board of Trade limits with 100-volt two-wire supply, and as a result a large number of converters are put in, very few of which are loaded to anything like their capacity. The magnetising power of the 10 or 20 kilowatt size is approximately 250 to 300 true watts, and does not vary appreciably with a change in size. Thus to work efficiently, as small a number of converters as possible should be used, and they should be as large as the official approval to the system will permit. This reduces waste energy, capital cost and attendance. With a large number laid down, the wages of attendants to periodically inspect each transformer and switchbox at short intervals become a serious matter, and in the event of faults or other trouble, much time is taken up in traversing the district to locate the position and put things right.

We must have—

| | |
|---|---|
| Either a large number of transformers at short distances apart, | Leading to unnecessary capital, expenditure, large (comparative) magnetising loss and disturbance of footways. |
| or, | |
| Smaller number of transformers, with large L.T. mains, | Involving disproportionate expenditure on distributing system. |
| or, | |
| Higher secondary pressure. | Enabling small number of transformers to be used, with ·1 square inch or ·2 square inch distributors and moderate drop. |

It is unnecessary to dwell upon the question further. A high-voltage secondary supply seems to be the one thing required to make street transformer distribution a success on a large scale.

### (e) *Fire Risk.*

Coming now to the objections that have been urged against higher pressures, the first is the increased danger from fire. This, Mr. Barnard thinks, is negligible, because he has found that deficient carrying capacity is more common than bad insulation. This is not what we have found in our experience of jerry-wiring, and it is much more likely that low-class wiremen should be as indifferent as to the insulation they use, and the covering put over joints as they should be on the matter of securing proper mechanical and electrical connection between circuit and branch at the joints. Nor is this opinion ours alone, for Mr. Baynes's rules at St. Pancras prescribe the use of 2,500 megohm wire and the separation of joints on the contiguous wires of a circuit by a space of 8 inches.

The three conditions that require to be given special attention are:—

1. Efficient insulation of wires and fittings, with special regard to joints.
2. Ample length of break on switches and fuses, and the abolition of double-pole accessories.
3. Sufficient copper in all conductors, switches, and fittings, to keep the density down to something below 1,000 amperes per square inch.

Although it is urged that "there is nothing to fear on the score of increased fire risk, as the halving of the current quite balances the objection to the pressure being doubled; that it is not the insulation of the wires that is at fault in an old installation so much as the badly-made joints and overloaded wires; that in most accessories the E.M.F. has been amply provided for—but the carrying capacity of the screws, terminal, and contact plates is sadly over-estimated," we know from years of experience that when dry joints, and the like, are met with, there it will be found that the insulation provided is a wisp of black tape, that not one of such joints will stand moisture, and, generally, that bad work and inferior fittings mean scamped wiring in all its hideousness. The outlook for higher pressures is, therefore, anything but reassuring, and Mr. Wordingham has done well to utter a warning that ordinary fittings cannot be used with safety.

On this account, the change from 100 or 110 volts to 220 volts should not be countenanced. Work put up for the lower pressure must inevitably be found to give trouble when double the stress is put on, and some other way of meeting the growth of the business should be faced where the existing mains are fully loaded.

The advantages, *a*, *b*, and *c*, of higher pressures, by which an improved service, increased main capacity, and better efficiency is hoped to be obtained at high voltage, should not be allowed to usher in the change that more likely than not will be accompanied by trouble in the house circuits. A change of this nature is anything but desirable, and we think that borough electrical engineers should have some consideration for safety, as well as economy, in mains. We may be told that what we think will not happen. We do know this, however, that with only 100 and 110 volts numerous faults develop in ordinary house wiring, and it is only by the combined efforts of central station inspectors, and fire office surveyors, that electric fires are not more common than they are.

*(f) Extensions.*

While a change of pressure in districts already supplied, carries with it a very grave element of danger, there is a direction in which the high voltage lamp materially assists the station engineer. This is in the case of extensions. Either a three-wire system with 440 volts across the outers, or a plain two-wire at 220 volts must bring with it all the benefits that have been referred to above. New customers can be taken on at greater distances from the generating or sub-station than would otherwise be possible, and as the "declared pressure" is made public before wiring is commenced, contractors would be prepared for the high voltage.

The essentials to success are a proper set of rules for wiring, which must be duly enforced, early intimation that the higher pressure will be that of supply, and a warning to applicants for electrical energy that wiring must be carried out in a way befitting the circumstances with single-pole switches and cut-outs, and in adherence to the requirements of the undertakers. Where this is done the fire risk is reduced, and no greater danger is incurred than with ordinary wiring and low pressures.

Messrs. Jackson & Stewart were the only two speakers at the Convention who opposed the movement. They based their arguments on the efficiency and sizes of lamps available. This contention we have shown to be of little importance. In short, we may say that:—

I.—Change-over.

High voltage for customers formerly supplied at low pressures is unnecessary, dangerous, and bad engineering, because the conditions are all against such a change, and the supply will benefit at the expense of those supplied.

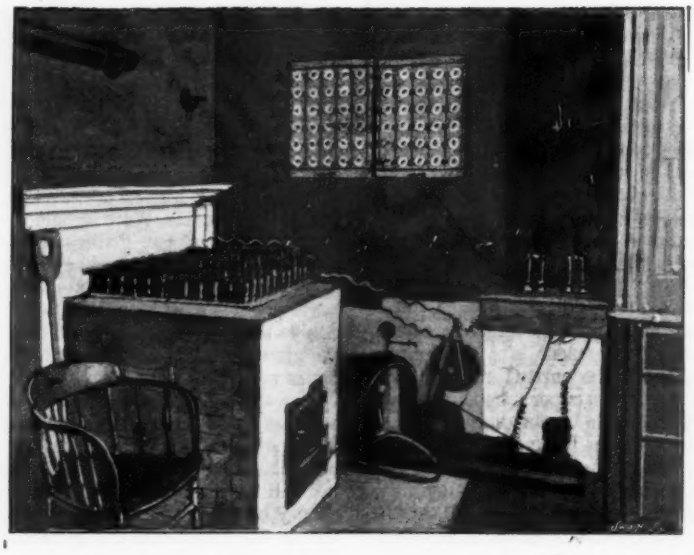
II.—Extensions.

High voltage on extensions is advantageous, because it reduces capital expenditure, effects economy in working, gives better service, leads to increased capacity in mains, allows district to be rapidly extended, and the dangers can be minimised by insisting upon wiring work being carried out in a befitting manner, and suitable for the pressure of supply.

## THE JACQUES CARBON GENERATOR.

A new generator which has been invented by Dr. William W. Jacques, of Boston, professes to produce electricity directly from the consumption of carbon in a primary battery, and to transform into electric energy 82 per cent. of the total energy which the carbon is capable of producing.

In the Jacques generator, which is illustrated in fig. 1, a carbon, C, is plunged into a solution of caustic soda, E. A pump, A, forces air into a perforated nozzle, R, which distributes the air uniformly in the electrolyte. The positive pole is fixed upon the iron receiver, I, containing the solution, and the negative pole upon the carbon, C, which is supported and insulated from the receiver by a collar, S. Two tubes, *o* and *i* serve for the admission and discharge of the solution. The whole is placed in a furnace which keeps the temperature of the bath at 400° to 500° C.



Under these conditions, it is said the carbon is gradually converted into carbonic acid gas and escapes in bubbles; the composition of the sodic hydrate is not modified; the nitrogen is liberated and, having no affinity for the other bodies present, escapes along with the carbonic acid gas.

A certain quantity, however, of the carbonic acid gas combines with the caustic soda to form carbonate of soda, and this mixing with the refuse from the carbon, contaminates the electrolyte and diminishes its efficacy. This inconvenience is remedied by discharging, by means of the tube *o*, part of the exhausted liquid and replacing it with fresh liquid by means of the tube *i*.

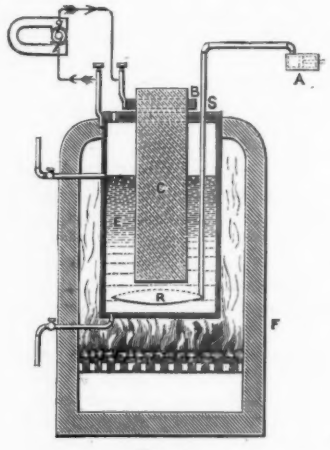



Fig. 1.

Such is the description of the Jacques carbon cell as it appeared in the American technical papers about two months ago. Quite recently Dr. Jacques has constructed and brought out a battery made up of 100 of these cells, from which the wonderful results first mentioned have been obtained.

This battery, which is shown in our illustration, is made up of 100 cells, arranged in series. Each cell consists of an iron pot 1½ inches in diameter, and 12 inches deep, and contains a cylinder of carbon, and the fused caustic soda. The cells are compactly arranged over a furnace, as may be seen in the illustration; sufficient heat being generated in the furnace to keep the caustic soda in a fused condition. An air pipe reaches down into each pot, all the pipes being connected together so that they can all be supplied by one pump.

At the invitation of Dr. Jacques, this apparatus was examined and tested by Professors Rowland and Cross. In his report, Professor Rowland said: "It has long been known that, if the oxygen of the air or free oxygen could be made to combine with carbon in such a way as to produce electrical energy, instead of heat, an enormous economy would be effected. Dr. Jacques has accomplished this, and I believe he is the first who has done so. Not only is Dr. Jacques the first to my knowledge to show how the oxygen of the air or free oxygen may be made to combine with carbon to produce electrical energy, but he is the first to show, so far as I know, any practically operative process, by which electricity may be produced, through the oxidation of carbon."

Tests of the 100 cell battery were made under Prof. Cross's direction. With this battery Dr. Jacques was able to operate 30 16-candle incandescent lamps at full brilliancy. It was found that to maintain these lights for 18¾ hours, required the consumption in the pots by oxidation, of about 8 lbs. of carbon. It was also found that the average pressure was 90 volts, and that the average amount of current was 16 amperes. With these data a little calculation will show that the energy given out by the battery is equal to about 80 per cent. of the maximum energy that could possibly be produced by the combustion of the 8 lbs. of carbon consumed in the pots.

When we recall the fact that the best steam engines give only 5 or 6 per cent. of the total energy in the fuel, the efficiency of the Jacques generator is truly astounding, and this result would probably be received with a considerable amount of incredulity if it were not supported by such high authorities as Professors Rowland and Cross.

A very important omission, however, appears to have been made. No estimate is given of the amount of coal consumed in the furnace in order to keep the caustic soda in the fluid condition, nor of the amount of energy expended in pumping the air into the pots. This is stated to have been insignificant compared with the energy consumed in the battery, but we should like to see the figures.

Mr. C. J. Reed, who is a great authority on the carbon generator, and generally acts as the *advocatus diaboli* to every new invention in this field, considers that Dr. Jacques's generator is not a galvanic battery consuming carbon, but a thermo-electric generator deriving its energy from the carbon consumed in the furnace and not from the carbon consumed in the pots. Decidedly there is nothing in the tests already published to negative this view.

Numerous experimenters have shown that thermo-electric currents are generated by the contact of metallic or other electrodes with fused salts. In 1837, Andrews obtained such currents by fusing a bead of borax on a platinum wire, and then dipping into the bead another cold platinum wire. Becquerel in 1854 obtained a current by fusing potassium nitrate in a platinum crucible and dipping therein a rod of carbon. Hankel, in 1858, made a series of experiments on a large scale. Alkaline and alkaline earthy haloids and other salts were melted in a platinum crucible. Platinum, gold and silver wires were dipped in the salts and the current measured by a galvanometer. When the crucible and its solid contents were slowly warmed, the current first flowed from the hot crucible through the mass to the wire; when the salt melted at the sides of the crucible, the current was reversed; and when the whole mass was melted the current returned to its original direction. Jablochkoff, Brard, and others have made attempts at constructing carbon consuming batteries with fused salts.

In the Jacques generator, the use of fused caustic soda and air jets around the carbon appears to be new. If, however, the thermo-electric theory is right, the air jets may merely act as a cooling agency for one set of the junctions of the thermo-electric chain. Before we can be sure as to the nature of the action of this new generator, the gases given off by the battery must be estimated, as well as the coal used in heating the solution of caustic soda.

From the practical point of view, however, it matters little whether the Jacques generator is a thermo-electric generator or a carbon consuming primary battery. What we want to know is the ratio of the energy given out to the total energy consumed. We also want to know the first cost and cost of maintenance. When these data are given we can tell whether the Jacques generator is any advance on our present means of generating electric energy. Such fragmentary tests as have been already submitted, tend merely to excite the suspicion that there is a fatal weakness somewhere in the invention which will ultimately condemn it as a practical generator of electric energy.

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**Celluloid and Accumulators.**—An object lesson in the use of celluloid envelopes for enclosing secondary battery plates may be taken to heart by the casual inspection of a set of large cells at the Imperial Institute in the gallery devoted to motor carriages, model flying machines, &c.

## MAGNETIC FATIGUE.

By ED. C. DE SEGUNDO, Assoc.M.Inst.C.E.

The recent papers on "Magnetic Testing of Iron and Steel," by Prof. Ewing, and "Magnetic Data of Iron and Steel," by Mr. Field Parshall, read at the Institution of Civil Engineers, deal with the subject of magnetism from a commercial point of view in a most useful manner, in a manner which appeals very strongly to the engineering mind.

The reading of these papers at the Institution of Civil Engineers immediately after the most able James Forrest lecture delivered by Dr. Kennedy, cannot fail to be considered peculiarly *à propos*, inasmuch as the labours of these gentlemen in collecting, classifying, and tabulating, so many experimental results obtained in exactly the spirit and in the directions which were referred to in Dr. Kennedy's lecture as of paramount importance to the advance of engineering science, may be considered an undesigned tribute to the truth and justice of the conclusions arrived at by Dr. Kennedy, who may justly be said to be the pioneer of exact engineering experimental science.

A very important matter, from a practical point of view, was dealt with during the discussion by Dr. Fleming and Prof. Ayrton, namely, the peculiar characteristic possessed by iron to deteriorate magnetically, if one might use the expression, under the influence of long continued reversals of magnetism such as occur, for instance, in the core of a transformer. Every one is fully alive to the very great importance of transformation, particularly in dealing with electric light or power transmission problems involving supply in a scattered area or at points a very long distance away from the source of energy, and therefore this effect, which perhaps might be called "Magnetic Fatigue," is one which, it is easily recognised, would have a great influence indeed upon the economical aspect of the methods adopted in the solution of the above-suggested problems.

The analogy between the experiments of Wohler on the influence of continued variations of stress upon the ultimate strength of various metals and the magnetic "sticktion" in the iron of a transformer core after some years of service, is interesting.

Wohler showed that variations of stress, of which the higher limit was only a little in excess of that corresponding to a well-defined elastic limit in the materials under experiment, brought about fracture or rupture if only repeated long enough, but that if the variations, though perhaps changing from tension to compression, were well within the elastic limit, the material would suffer no degradation even after many millions of alternations of stress.

In the case of a transformer core, however, the effect of the deterioration is not *similar*; the material becomes more sluggish in its response to the inductive influence, it loses magnetic elasticity, and its magnetic inertia, so as to speak, is increased, but it is *analogous* in that by long continued reversals of magnetism, even as by long continued reversals of mechanical stress, the material becomes less efficient for the purposes for which it was intended.

After all there is nothing surprising in this increase of hysteresis loss with time. Clearly the natural condition of iron is unmagnetised, and it is common experience that any interference with nature is not indulged in with impunity.

It will be remembered how Wohler's results when first published completely modified our preconceived ideas and principles underlying the design of such structures, as, from the nature of the load they are intended to bear, may be subjected to rapid alternations of stress, either between the limits of low and high positive value, or between negative and positive limits. The line of experimental research suggested by Wohler has by no means yet been followed to its extreme limit, not for the lack of enthusiastic and willing workers, but because of necessity such experiments must spread over a very considerable period of time, and although we know enough at present of the fatigue of metals to prevent a serious blunder in design, it cannot be safely said that experiments have gone so far as even to be within measurable distance of exhausting the field of research.

Analogy does not constitute logic nor yet legitimate argument, but it cannot be denied that analogy is extremely fascinating, in that it is so highly suggestive. In this par-

ticular connection we have two analogous phenomena which appear to arise from analogous causes. They are certainly brought about by analogous treatment. May we not, then, hazard the view that the analogy may be continued so far as to suggest to us that there is a limit to the value of "B," corresponding to the limit of elasticity in materials of construction between which alternations of induction, however rapid and however long continued, would not bring about the molecular change, or whatever it may be in the structure of the material, which causes this disinclination on the part of the material to respond to the influence of magnetic lines of force?

It would certainly seem that Prof. Ayrton's terse remarks in the discussion on the papers above alluded to were pregnant with a meaning which perhaps did not appeal to the whole of the audience who heard him, and it may be said, with much justification, that further time and energy spent in the determination of the hysteresis loss in various different samples of iron are certainly of little value in arriving at the best material for transformer cores, as long as the laws governing the time value of "Magnetic Fatigue" are not known.

It is by no means unlikely that the more permeable specimens may be the very first to show a marked magnetic fatigue.

It would not be difficult to design and carry out a series of systematic experiments designed to reveal the existence of such laws (if they do exist), and with the facilities at our disposal in the numerous efficiently equipped electric laboratories which now exist in many parts of the country, it would be an interesting and instructive task, the results of which would be of untold value to the engineer.

## REVIEWS.

*The Application of Graphic Methods to the Design of Structures.* By W. W. F. Pullen. Manchester: The Technical Publishing Company.

The title of this book is rather a misnomer, for there is a great deal of analytical work in the later chapters, more particularly what might have, with advantage, been replaced by further dealing in graphics. There is also considerable space allotted to considerations of the resistances of materials and details of construction not properly forming a portion of a treatise on graphic methods. The book is practically a reprint of articles that have appeared in the pages of the "Practical Engineer." Graphics as a means to correct design is too little known or practised. Yet when the student has mastered its first difficulties we think the graphic method will appeal to him very strongly, especially if he be not very secure in his mathematics. To the non-mathematical mind a false quantity in an equation does not make itself manifest with the clearness with which a false quantity so aggressively obtrudes itself in a graphical diagram. While quite agreeing with the author that problems in graphics are merely a species of mathematical exercise when viewed apart from their practical applications the fact remains that graphics must always stand alone, and this cannot be held to form an excuse for devoting so much space to merely extraneous matter. The bridge designer who uses graphical methods does not need the author to tell him anything of practical stresses. All he wants to know is, given certain panel point loads to find the stresses induced thereby, and he finds these by the stress diagram, and makes all the practical allowances for vibration, for length of compression, members, and so on, which he cannot learn either from graphical or analytical methods. In this way the author has rather gone out of his way to deal with matter extraneous to the subject in a brief manner with recommendations to more advanced works. The chapter on counter bracing, though short, is good, and, generally, the book is not one to condemn. We cannot say we like the type, it is not easy to read. Letters and figures of definition are too similar to the ordinary letterpress, in the midst of which they are crowded. As bearing on the general character of the teaching, rather than on the specialism indicated in the title, the length of the plates in the flanges of a plate girder is first found analytically, and the graphic method introduced almost apologetically. It should have been entitled stress determination in framed structures.

*Electric Light and Power Distribution.* By W. Perren Maycock, M.I.E.E. London: Whittaker & Co. Vol. I. Third edition.

This work is a vast improvement on the last edition, catalogue illustrations and external views of machinery having been almost entirely eliminated.

The first two chapters deal with units, formulæ, and figures, fully and sufficiently for the student. Chapter 3 deals with magnetism principally; in this chapter it might have been as well to impress the fact that all lines of force are closed circuits, the student is apt to fail to grasp this fact. There is no such thing as "free magnetism" this expression occurs in works of much greater pretensions than this one, and has a most mischievous effect on student's ideas. The magnetic field is rigidly attached to the magnet or solenoid, or whatever sets it up, it goes with its magnet and none of the lines of force can be freed. It may be said that the vast progress made in electrical engineering about 10 or 12 years ago was entirely due to the realisation of the importance of the "magnetic circuit," and that what had hitherto been called "free magnetism," was neither more nor less than a magnetic flow in a direction and place where it could not be utilised; it has ever since been called magnetic leakage. The sooner the idea of "free magnetism" is stamped out the better.

In the science of magnetism the student must first of all be taught that magnets are used to force magnetic flow—current, or lines of force—through something to produce some desired effect, and the way to give an idea as to the best design for the purpose can be arrived at only by considering the magnet and the body acted upon as part of a complete circuit; the force passing through the body to be acted upon is useful; the rest of the force which misses the body and flows through the surrounding space, is no more free than the force in the magnet or in the body acted upon; it is useless or worse. In the 4th chapter, induction of electric current by magnets would be better illustrated by interlinked rings of copper and iron.

Chapter 6 deals with the magnetic circuit very well indeed; but here, again, it would have been better to discard the distinctions made between magnetism in air and in magnetic bodies; the author gives seven terms meaning the same thing, namely, the number of lines per unit area passing through the magnetic circuit, and suggests flux density as the best term; most practical people will agree to that.

With these few exceptions Chapter 6 is a first-rate treatment of the subject. Chapter 7, and on to the end, are all very well fitted for the use of students, and convey accurate knowledge of the measuring apparatus in use; also correct views, illustrations and descriptions of most modern dynamos, motors, &c. The work will no doubt become a standard text book for schools and classes on this subject; as such it has few equals.

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*The Alternating Current and Transformer in Theory.* By J. A. Fleming, D.Sc., M.A. London: *Electrician* series.

This is the first volume of a new edition of the author's former work on the same subject, it has been very much enlarged, and now embraces valuable matter on Hertz and other recent workers.

The dynamical theory of induction is fully treated.

Chapter 6 is a very valuable treatise on induction coils and transformers.

Electro-magnetic induction is completely dealt with without once introducing "free magnetism." It is a valuable work for advanced students and scientific electrical engineers. The treatment is clear and the illustrations well chosen.

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*Les Nouveautés Electriques.* By Julien Lefevre. Paris: J. B. Bailliere et Fils.

This in its way, is a useful and instructive little work, dealing in a popular style with recent developments in magnetic and electric discoveries.

High pressure oscillatory currents and their properties are treated, and apparatus for experiments described. Effects of currents of high frequency are also described with apparatus for experiments.

Polyphase currents are then entered upon by simple experiments.

Recent primary batteries, De Laval's steam turbine, some new dynamos, notably one by M.M. Hutin and Leblanc, in which the commutator is separate from the machine, and forms a sort of rectifier, follow.

A dynamo mounted on a pillar is shown, coupled to a wheel and a pair of bicycle pedals; a bicycle saddle is provided also on the pillar, so that healthy exercise and electric current can be got at home.

Electric heating, electric tanning, electric welding, extraction of aluminium and many other new processes are described. Altogether it is a very interesting work.

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*Theorie de L'Electricité.* By A. Vaschy. Paris: Librairie Polytechnique, Baudry et Cie, Editeurs, 15, Rue des Saints-Pères.

Any work by M. Vaschy must command more than ordinary respect, and the present production is fully up to what might be expected from the author. The electric and magnetic forces are dealt with in the same way as would be the case with other forces, no special treatment being adopted. As a mathematical treatise the work is a learned compilation, and is one which should prove to be of distinct value to advanced students.

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*Engineer Draughtsman's Work.* By A Practical Draughtsman. London: Whittaker & Co., 2, White Hart Street, Paternoster Row.

This book deals with the various instruments used in a draughtsman's office, and gives various hints as to their use; levelling and surveying, and the steam engine indicator are also considered. A chapter on "Branches of Scientific Knowledge Advisable to be Studied by Draughtsmen" is not particularly valuable as a guide, in fact it is of a decidedly hazy and unsatisfying nature.

Seeing that neatness and accuracy should be the aim of every draughtsman, the quality of the illustrations is not such as to impress one. Indeed, the modern and growing practice of cheaply illustrating books by means of *fac simile* productions of figures apparently scribbled with a pointed piece of wood on blotting paper is not one which calls for admiration. With all its defects, however, the book is really of good practical value and deserves commendation.

## CORRESPONDENCE.

### Some Reflections and a Moral.

It is doubtful whether such criticism as that offered by your correspondent J. M. B. will enable us to get much nearer a solution of the great question as to what is to be the next phase of the electrical industry. No doubt R. P. S. has laid himself open in his article bearing the above title, to some criticism, but surely it would be much more to the point to tackle him on the main question than to indulge in frivolous cavilling at possible faults of style.

That the "Reflections" of R. P. S. deserve the serious consideration of all interested in the electrical industry is beyond question, but that the facts he sets forth respecting the General Electric Company justify his conclusions is open to doubt. I presume R. P. S. would not be bold enough to assert, in so many words, that one large combination having failed, another will necessarily not succeed, and yet, this I conceive to be the teaching distinctly implied in his article.

It is unnecessary to go into the figures of the General Electric Company's balance-sheet, the significant fact being, as R. P. S. very rightly says, that the profits on the turnover have almost disappeared. The other matters referred to, such as the shrinkage of asset values consequent on the depreciation of shares in affiliated enterprises, the gradual discovery that stock has become obsolete, and that patents have lost the greater part of their worth, have their counterpart at home, with the inevitable reduction of capital following to set the enterprise on its legs again. That blind unreasoning competition here, as in the States, has brought the industry to a bad pass is amply revealed by a study of market share values and published balance-sheets. Moreover, all the history of the American Company has been repeated, though on a smaller scale, on this side. All the financial changes have been rung, and the result is what we see to-day. The only satisfaction to be derived from reading such melancholy history is found in observing that those who have been the greatest sinners are now the greatest sufferers.

I take it that R. P. S. wishes us to set our house in order, and holding up the General Electric Company as a frightful example, declares that "combination" does not indicate the manner in which this should be accomplished. The consideration as to whether combination would at present be beneficial to the industry I am not touching upon, but I hold that the position taken up by R. P. S. is untenable. The implication that combination would not succeed in this country is illogical, because it does not follow that the same errors would be repeated, or that the business would be conducted on the same lines, or that similar disturbing factors would be present from the beginning. There are, of course, combinations and combinations. A further implication in the article, namely, that a combination of interests is less able to face the competition of those who refuse to come in, than if such combination did not exist, is too antagonistic to generally received opinions to be seriously considered.

In conclusion, my friend R. P. S. is too sanguine as to the effects of "competition tempered and informed by a spirit of mutual goodwill and understanding among the competing interests." This sounds well, but it is not convincing. It is true, there is wise co-operation amongst manufacturers for the purpose of securing conditions of purchase more favourable to competitors as a body, but unless combination in some form or other comes to pass, the natural and obvious result of securing relaxation of some of the more stringent conditions of contracting must be a further lowering of prices. Competition under the present régime will rage just as fiercely as ever, and at the moment there is no sign whatever of its abatement.

W. B. Esson.

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### The Electrical Resistivity of Bismuth.

A communication was made on Thursday last to the Royal Society, by Prof. Dewar and myself, in the form of a letter addressed to the President, of which the following is a copy:—

[Copy.]
The Royal Institution,
Albemarle Street, London,
June 18th, 1896.

To the President of the Royal Society.

Dear Sir Joseph Lister,—In continuing our experiments on the electrical resistance of bismuth at low temperatures and in magnetic fields, by the aid of a powerful electro-magnet kindly lent to us by Sir David Salomons, we have observed the fact that a wire of electrolytic bismuth, when cooled in liquid air to a temperature of − 186° C., has its resistance increased more than 42 times, if it is at the same time transversely magnetised in a field of 14,000 units. The bismuth, when cooled in liquid air, and thus magnetised, has its electrical resistance increased more than 15 times, even when compared with its resistance at ordinary temperatures, and not in a magnetic field. There is no reason to believe we have reached the limits of this increase. Reserving further details for a full communication to the Royal Society later.

We remain, yours very truly,
(Signed) James Dewar,
J. A. Fleming.

It may be interesting to give the exact figures of observation for the information of your readers. The wire of electrolytic bismuth had a resistance of 1·46 ohms at 19° C. when not in a magnetic field. If placed transversely to the field in a field having a strength of 14,150 C.G.S. units, its resistance was increased to 2·34 ohms at 19° C., or 1·6 times. This, of course, is a well known effect. If the same wire, however, was placed in liquid air and cooled to − 186° C., its resistance fell to ·53 ohm. If then placed transversely to the field in a field of 14,150 units, its resistance immediately increased to 22·4 ohms, or 42·2 times. Hence the bismuth cooled to − 186° C., and in the field of 14,150 has a resistance 15·3 times greater than at 19° C., and not in the field. There is a certain value of the field which just neutralises the diminishing effect of cooling on the bismuth resistance, and leaves the wire when cooled in liquid air, and in the field of the same resistance as when not cooled and not in the field.

J. A. Fleming.

University College, London,
*June 20th*, 1896.

### Cooling Systems for Condensing Water.

With reference to your article in the REVIEW of this week, perhaps a few details of a condensing plant which the writer installed in 1892 will be of interest to your readers.

The plant for electric lighting and power consisted of one 10 H.P. nominal compound, and one 20 H.P. ditto driving dynamos. Steam was supplied from three 30 H.P. Babcock boilers at 120 lbs. pressure.

The condensing apparatus consisted of a duplex Worthington air and circulating pump, with a surface condenser containing 300 ⅝-tubes 5 feet long; the tubes were held in the tube plates in the usual way with taper wood ferrules at each end, and gave no trouble.

The circulating water was taken from a circular pond 60 feet diameter, 3 feet deep, with sides sloping at 45°. The engines were run usually both together, and at about 90 H.P. indicated, the time, of course, varying with the season.

During the months of July, August, and September, the average daily run would be about 5 hours, and the cooling water would be from 100 to 115° F. at the surface. The overflow was raised about 5 feet from the water level, and the water broken by rock work. The usual working vacuum was 25 inches.

At first, difficulty arose from the water fouling with green weed and choking the tubes and valves, but at the suggestion of the writer about 200 gold fish were introduced to the pond, and they, together with their families, kept the vegetable matter down within reasonable limits. The fish, contrary to all expectations, seemed to like the hot water, and were to be found swarming round the overflow where the water was hottest. They also bred in a most astonishing manner.

The condensing apparatus was, in my opinion, a great success, and the fact of engines running with a vacuum on the exhaust means more than meets the eye.

I am glad to see you advocate the use of condensers, for the reason that I was most unmercifully criticised by an eminent consulting engineer who was called in by my principals to report upon certain alterations I wished to carry out.

He delivered a most *massive* report *verbally* in which he condemned condensing arrangements *in toto*, and mentioned the fact that torpedo boats simply used them to hide their steam from the enemy, and then spoke of me in terms of endearment because I had not connected the boiler feed pumps to the condenser, and thereby saved two-thirds of the steam. I enclose my name, and beg to remain,

**Fish Ponds.**

*June 16th.*

### Half Truths and Whole Truths.

In your last issue you state that, in order to make out a case for the simplicity of the Daimler motor, I only give a half-truth in my letter of the 12th inst., by which you still seem to infer that I am personally interested in this motor. I must say that I most certainly am not.

As you refer to Sir David Salomons again, and also state that "one of the difficulties in France at the present moment is, that trained drivers of self-propelled carriages can only be found by obtaining mechanics from the manufactories," allow me to refer you again to the pamphlet on "Horseless Carriages," which says (see page 25), referring to a well-known actress of the Theatre Français, who drives in a motor Victoria, "She had started this carriage from motives of economy, and *her coachman* had been broken in to drive the new horse."

In another note in your last issue, headed "A Horseless Carriage Authority on Accumulators," you err in the same manner as you state me to do, namely, by quoting half-truths. The first paragraph from which you quote continues:—"In the case of a private carriage, the weight is, of course, greatly reduced, and *the consideration mentioned does not enter;* whereas the advantages offered by the use of electricity are very considerable."

I think further comment unnecessary.

**F. J. Warden-Stevens.**

*June 22nd*, 1896.

[So do we.—EDS. ELEC. REV.]

### Electrozone.

Can you tell me what is the wonderful substance, largely advertised in this country since a few days, under the name of electrozone? What is electrozone?

Is it a compound of electric ozone and of some disinfecting and medicinal liquid, on which this unstable body is fixed?

Is it a product of electrolysis which contains ozone? If ozone can be kept bottled, this electrozone, no doubt, will render great services, especially if the proportion of ozone is considerable.

**Leonardi.**

## LEGAL.

### ELECTRIC CONSTRUCTION COMPANY *v.* HURRY AND YOUNG.

THIS action, which came before Lord Low at the Edinburgh Court of Session last week, was a claim for payment of £50 odd, the price of a dynamo supplied to defendants in September, 1894. The defendants, an Edinburgh firm of electrical engineers and contractors, refused to pay, on the ground that the machine did not conform to contract. The dynamo was a No. 3, ordered to give an output of 40 amperes at 115 volts at 1,100 revolutions per minute, and defendants stated that although when first set in motion at 1,100 revolutions the stipulated 115 volts were obtained, the voltage rapidly dropped, and, after a few hours' running, it was impossible to obtain more than 100 volts, though the number of revolutions was the same. Insufficient and defective lighting was the consequence. Complaints were made to plaintiffs, who sent a new armature, but this, after a short time, allowed the voltage to drop as before. Various complaints were made, and the machine was again attended to by plaintiffs, but it was invariably found that the voltage dropped 5 to 10 volts in a few hours running. Defendants stated they had suffered loss and damage through plaintiffs failing to supply a dynamo to conform to the order, and they counterclaimed damages.

Counsel for plaintiffs: Mr. Salvesen and Mr. Constable. Agents: Wallace & Pennell, W.S., Leith.

Counsel for defendants: The Solicitor-General and Mr. Clyde. Agent: Richard Johnston, S.S.C., Edinburgh.

For the plaintiffs, Prof. Bailey, of the Heriot-Watt College, Edinburgh, did not consider a drop of 10 volts after 5½ hours' running excessive. Mr. Blackman, Aberdeen Corporation electrical engineer, also gave evidence to the same effect.

For the defence, Mr. W. A. Bryson, Mr. T. Crichton Fulton, Mr. Alex. Ogilvie, and Mr. O. Cox-Walker, all stated that a 10-volt drop was excessive, and a drop of 2 or 3, or at the outside 4 per cent., was all that should be allowed.

Lord Low came to the conclusion that the dynamo did not conform to the contract, and held that there was a timeous rejection of the dynamo, and was therefore of opinion that defendants were entitled to set up the breach of contract as in extinction or diminution of the price. He therefore pronounced an interlocutor, in which he assoilzied the defendants from the conclusions of the action, and found them entitled to expenses.

### JARDINE *v.* KING, MENDHAM & Co.

IN the Chancery Division of the High Court of Justice, on Tuesday, the 23rd, Mr. Justice North delivered his reserved judgment in this action, which was brought to restrain an alleged infringement by the defendants, a Bristol firm, of the plaintiff's patent for electric automatic checks.

His LORDSHIP said that several points had been raised in the course of the case which he did not think it necessary to consider, as he had come to the conclusion that the defendants' machine was not an infringement of the plaintiff's patent. Automatic time checks, for checking the times at which workmen arrived at their work, were well known things at the date of the plaintiff's patent, and he came to the conclusion that there was a substantial difference between the method by which the plaintiff and defendants arrived at their ends. He could not say that the defendants' machine was a colourable imitation of the plaintiff's, nor was it equivalent to the plaintiff's process. The action was accordingly dismissed, with costs.

### TAYLOR *v.* TITMOUSE.

IN the Westminster County Court, on Wednesday, this case came before his Honour Judge Lumley Smith, Q.C., and was a claim for £2 15s., balance of an account for work and labour done for defendant by plaintiff, an electrician.

Mr. Merton appeared for the plaintiff, and Mr. Jolly for the defendant.

The case for the plaintiff was that four electric lights were fixed at 23, Northumberland Avenue, Charing Cross, for which a fair and reasonable charge had been made. Defendant never raised any objection until sued, and had paid £6 on account.

The defence was that the work was not properly done, and Messrs. Fraser, of Cecil Court, had to do it over again.

His Honour found for the plaintiff, with costs.

## BUSINESS NOTICES, &c.

### Electrical Wares Exported.

| Week Ending June 23rd, 1895. | £ | s. | Week Ending June 23rd, 1896. | £ | s. |
|---|---|---|---|---|---|
| Amsterdam ... ... | 65 | 0 | Alexandria. Teleg. mtl. | 240 | 0 |
| Aden ... ... ... | 10 | 0 | Amsterdam ... ... | 120 | 0 |
| Algoa Bay ... ... | 824 | 0 | Antwerp. Elec. fuses... | 165 | 0 |
| Antwerp ... ... | 15 | 0 | Bombay ... ... ... | 57 | 0 |
| Archangel ... ... | 189 | 0 | „ Teleg. apps. ... | 17 | 0 |
| Bombay ... ... | 39 | 0 | Boulogne ... ... | 70 | 0 |
| Brussels... ... ... | 158 | 0 | Brussels ... ... ... | 22 | 0 |
| Calcutta ... ... | 283 | 0 | Buenos Ayres ... ... | 194 | 0 |
| Cape Town ... ... | 30 | 0 | Calcutta ... ... ... | 93 | 0 |
| Colombo ... ... | 10 | 0 | Cape Town ... ... | 128 | 0 |
| Delagoa Bay ... ... | 33 | 0 | Colombo... ... ... | 33 | 0 |
| East London ... ... | 1,127 | 0 | Durban ... ... ... | 705 | 0 |
| Gothenburg. Teleg. mtl. | 13 | 0 | East London ... ... | 65 | 0 |
| Lisbon ... ... ... | 12 | 0 | Fayal ... ... ... | 15 | 0 |
| Madrid ... ... ... | 20 | 0 | Flushing... ... ... | 10 | 0 |
| Oporto. Teleg. mtl. ... | 20 | 0 | Fremantle ... ... | 41 | 0 |
| Otago ... ... ... | 152 | 0 | Gibraltar ... ... | 36 | 0 |
| Port Natal ... ... | 26 | 0 | Gothenburg. Teleg. wire | 17 | 0 |
| „ Teleph. mtl. | 80 | 0 | King George Sound ... | 13 | 0 |
| Suez. Teleg. mtl. ... | 30 | 0 | Oporto ... ... ... | 31 | 0 |
| Sydney ... ... ... | 76 | 0 | Passages. Teleg. mtl. ... | 24 | 0 |
| Shanghai ... ... | 1,415 | 0 | Port Elizabeth ... ... | 425 | 0 |
| Teneriffe. Teleg. mtl.... | 70 | 0 | Rangoon ... ... | 14 | 0 |
| Tientsin. Teleg. mtl.... | 366 | 0 | Santos ... ... ... | 31 | 0 |
| Wellington ... ... | 116 | 0 | St. Petersburg ... ... | 38 | 0 |
| Yokohama ... ... | 122 | 0 | Shanghai ... ... | 120 | 0 |
| Yokosca... ... ... | 1,205 | 0 | Stockholm ... ... | 620 | 0 |
| | | | „ Teleg. mtl.... | 224 | 0 |
| | | | Sydney ... ... ... | 498 | 0 |
| | | | Syra. Teleg. apps. ... | 50 | 0 |
| | | | Wellington ... ... | 140 | 0 |
| | | | Yokohama ... ... | 3,500 | 0 |
| Total | £6,624 | 0 | Total | £7,856 | 0 |

### Foreign Goods Transhipped.

| | £ | s. | | £ | s. |
|---|---|---|---|---|---|
| Barbados. Teleph. mtl. | 17 | 0 | | | |
| Buenos Ayres. Electric material ... ... | 43 | 0 | | | |
| | £60 | 0 | | | |

**Annual Outing.**—The second annual outing of the Regent's Park central station staff took place on Saturday, 20th inst. About 30 of the employés journeyed to Hastings, where they spent a most enjoyable day. Dinner was served at the Manor Hotel, Mr. T. Cooper, M.A., distributing engineer to the St. Pancras Vestry, being in the chair. At the conclusion of the dinner, before the customary toasts, the chairman read letters of regret from Mr. S. W. Baynes, chief electrical engineer, and Mr. E. Cox, chairman of the electricity committee, that they were unable to be present.

**A Pumping Catalogue.**—There is no doubt that the catalogue which secures the notice of those whom it is intended to serve, is the one which is got up in such a manner that one feels compelled to look at it, and having looked, cannot easily forget. We have before us at the moment one from the States, which, for artistic get-up and attractiveness, would be hard to beat. It is issued from the offices of the Snow Steam Pump Works, Buffalo, N.Y. It is devoted to pumping machinery, and that fact has put it into the active minds of the compilers to include some little sketches to illustrate the methods adopted by our ancestors for procuring water for various purposes; one of them shows a gang of men rushing to and fro with pails of water for putting out a fire. Every alternate page contains a large photograph of pumping engines of various kinds turned out at the works at Buffalo, of which a full page photograph showing the interior is given. The book was really issued as a "remembrance" of the American Water Works Association meeting in Indianapolis, in May, 1896, which Association visited the Snow Company's Works.

**Bronze Wire.**—A thick show card for hanging on the wall has been issued by the Phosphor Bronze Company, giving, in tabulated form, the approximate weights and electrical resistances of patent silicum bronze wire (cog-wheel brand).

**Electrical Engineering in Austria.**—It is now stated that Messrs. Schuckert and Co., of Nuremberg, with the view of developing their trade, have acquired the works and business of Messrs. Kremenezky, Mayer and Co., of Vienna.

**Fraud.**—H. B. Hunt, aged 35 years, a traveller formerly in the employ of Mr. J. H. Heathman, was, on June 19th, at Clerkenwell Sessions House, sentenced to six months' hard labour for collecting and appropriating money the property of Mr. J. H. Heathman, of Endell Street.

**To Creditors.**—Creditors of the Universal Electric Carriage Syndicate, Limited, are required to send particulars of their claims, &c., to the liquidator, Mr. W. O. Attree, at 41, Coleman Street, London, E.C., on or before July 1st.

**Personal.**—Mr. George Adams, whose contributions have occasionally appeared in the Electrical Review, is commencing business as a consulting electrical engineer at 55, Victoria Street, Westminster, S.W. Mr. Adams, we understand, has had a very varied experience with electrical and general engineering firms in different parts of the country during the past 15 years or longer. He has, during that time, been with Messrs. Hornsby and Sons, Messrs. Crompton & Co., Messrs. J. Fowler & Co., Messrs. Tangyes, the Brush Company, and latterly with Messrs. Grafton & Co., in some cases as draughtsman and in others as engineer. He also secured a City and Guilds of London certificate for mechanical engineering, and carried off, last year, first-class honours in electric lighting.

**To the Continent.**—The Great Eastern Railway Company's "Tourist Guide to the Continent," edited by Percy Lindley, will, with its useful maps, variety of illustrations, and large amount of letterpress describing the various places of interest, telling how to get there, and what the tourist should make a point of seeing, be found of great service. Wheelmen will find particulars at the end of the book of cycling distances, &c. The price is sixpence.

## ELECTRIC LIGHTING NOTES.

**Bedford.**—The Urban Sanitary Authority has resolved to inform the gas company that after January 1st next the use of gas lamps will be discontinued in certain stated thoroughfares. Electric lights are to be placed in certain streets where there have been no gas lamps.

**Bournemouth.**—The Town Council is asking the Electric Supply Company to submit a scheme and estimate for (*a*) the ordinary lighting of the Pier, and (*b*) the illumination of the Pier. What a satire on ordinary lighting.

**Bury St. Edmunds.**—The Ratepayers' Association has passed a resolution protesting against the borough electric lighting scheme and proposed expenditure of £20,000.

**Cardiff.**—At a recent meeting of a Corporation Committee it was stated that the borough engineer (Mr. Harpur) was overworked, and really had not time to prepare plans for the new fish market. One member suggested that Mr. Harpur should be relieved of the electric lighting supervision arrangements, as that was taking so much time, and likely to take more.

**Chester.**—The positions of the arc lamps were arranged last week, and wiring rules drafted by a sub-committee; 6d. per unit is to be charged.

**Devizes.**—A firm has applied to the Corporation for a license to enable it to supply the electric light to business places in the immediate vicinity of their works.

**Devonport.**—The Devonport Electric Lighting Order was read a third time in the House of Lords, and passed, on 18th inst.

**Edinburgh.**—The Royal Infirmary is to be supplied with current from the Corporation mains at 3½d. per unit. The electrical engineer has been instructed to take steps for the introduction of the high voltage system in the city.

The Electric Lighting Committee is to appoint an experienced man for calibrating the electric meters, at an annual salary of £150.

**Glasgow.**—The electric lighting rents at May 31st were £23,033 odd, showing an increase of £5,240 as compared with the corresponding period last year.

**Halifax.**—The Local Government Board have sanctioned the borrowing by the Corporation of a sum of £20,000 for the purposes of electric lighting, but in view of revelations made by the Town Clerk at the public inquiry in reference to previous loans having been utilised for other purposes than that specified on making the application, they have stipulated that in this case the loan must be applied to electric lighting purposes only.

**Hanley.**—The Incorporated Association of Municipal and County Engineers paid a visit to this borough on Saturday, June 13th, to study the results of the last ten years' municipal work under Mr. Lobley, the borough engineer. The company visited the electricity works and other places of importance in the district, and Mr. Lobley read a paper on "Some of the Public Works Carried Out in Hanley during the last Ten Years," his remarks naturally referring at length to the electric light undertaking, which also, along with electric tramways and electric transmission of power, was dealt with in the discussion.

**Huddersfield.**—The mains are to be extended along several thoroughfares.

**Hull.**—The report of the special Electric Lighting Subcommittee, *re* extensions, was before the Electric Lighting Committee the other day, and alternative schemes considered. The one the com-

mittee will recommend the Council to adopt is scheme C, and provides for one high tension generating station at Sculcoates Lane, with plant of 760 horse-power, and two sub-stations at Monument Bridge and Park Street, with distributing mains (minus the supplementary system), at an estimated cost of £40,679. The annual expenditure, including interest and sinking fund, is estimated at £3,786; the income from a supply of 170,000 units, at 5½d. per unit, £3,895, showing a profit of £109. The engineer recommends distribution from the sub-stations at 220 volts on the three-wire system. It is proposed to disconnect the consumers in the New Town from those in the Old Town, and to continue working the present plant for the supply of the area within the docks.

**Ireland.**—On 17th inst., in the Commons, a Bill was brought in by Mr. Tully, and read a first time, "to amend and extend the Towns' Improvement (Ireland) Acts with respect to the powers of Town Commissioners, who are not Urban Sanitary Authorities, to borrow money for purposes of electric lighting."

**Liverpool.**—On 16th inst., a Local Government Board inquiry was held respecting the application of the Corporation for power to borrow various sums, including £5,500, the estimated cost of lighting by electricity St. George's Hall, the Municipal Buildings, and the additions to the Town Hall.

**Mile End.**—The Vestry Electric Lighting Committee, which has visited Hampstead, St. Pancras, Brighton, Portsmouth, and Southampton electric lighting stations, has now reported in favour of lighting the district electrically, and recommends that application be made for a provisional order.

**Newcastle.**—The members of the Newcastle-upon-Tyne Association of Students (Institution of Civil Engineers) visited the stations of the Newcastle and District Electric Lighting Company, Limited, and the Newcastle Electric Supply Company, Limited, on Saturday last, under the guidance of Mr. Hunter and Mr. R. C. Jackson.

**Overseal.**—A deputation of the Parish Council, which recently waited upon Mr. John Hall regarding the question of lighting the village by electricity, reports that that gentleman would be willing to put down the whole of the plant, connections, and lamps required at his own cost, providing the Council would give him a lease of supply, and he would supply the Council or the village at so much per lamp per annum. He would give the Council a price shortly, and as he would also supply the church, chapels, schools, business houses, and any private house in the parish with the light, this would considerably cheapen the cost to the parish. Many people have already notified their intention of taking a supply if the village is lighted. The Council is inquiring the probable number of customers, and will, later, call a public meeting to adopt the Lighting Act.

**Poplar.**—The Board of Trade has promised to defer consideration of the revocation of the electric lighting order for another year.

**Shoreditch.**—Upon the recommendation of the Electric Lighting Committee the Vestry has decided that wherever the electric light mains are laid the existing gas lamps shall be replaced by 32 C.P. incandescent lamps, and the existing columns used. The tenders for insulated cables, switch and fuse boards, &c., have been referred to the Committee.

**Swanscombe.**—A member of the Parish Council has unsuccessfully attempted to get a resolution adopting gas lighting rescinded in favour of electric lighting. The gas contract has been signed.

**Swansea.**—Two proposals for electrically lighting the new market have been received from local men (Mr. J. Legg and Mr. J. S. Brown).

**Wakefield.**—The minutes of the Electric Lighting Committee adopted some days ago, show that preparations for laying down the plant are progressing satisfactorily. There were 31 applications for the post of clerk of works, and three are to appear before the committee.

**Watford.**—Engineers are being invited by the District Council to advise them in the preparation of a petition to the Board of Trade for a provisional order.

**Wells.**—By the casting vote of the chairman, the Town Council, some days ago, decided to inform the Gas Company that the negotiations for the purchase of their works are at an end. This is another step in the direction of electric lighting.

**West Ham.**—The report of the electrical engineer *re* electric lighting which appeared in abstract in last week's Review, has been adopted by the Council in committee, and the £67,000 is to be borrowed, application having been made to the Local Government Board.

**Windsor.**—Plans for the conversion of Albert Brewery into an electric lighting station for the Electric Light Company have been passed by the Council.

## TELEGRAPH AND TELEPHONE NOTES.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| Brest-St. Pierre (1869, Anglo) | April 6th, 1895 ... | ... |
| Puerto Plata-Martinique ... | Dec. 19th, 1895 ... | ... |
| Ceará-Maranham ... ... | April 28th, 1896 ... | June 19th, 1896. |
| Monte Alegre-Santarem ... | May 5th, 1896 ... | ... |
| Bissao-Bolama ... ... | May 30th, 1896 ... | ... |
| Cadiz-Teneriffe ... ... | June 7th, 1896 ... | ... |
| Jamaica-Colon ... ... | June 10th, 1896 ... | ... |
| Gibraltar-Tangier ... ... | June 16th, 1896 ... | June 18th, 1896. |
| **Landlines.** | | |
| Trans-Continental line beyond Masol (Mashonaland) | March 12th, 1896 ... | ... |
| Telegrams for Tohikwawa and Blantyre cannot be accepted. | | |
| Bolinao-Manila—telegrams are sent by post | March 19th, 1896 ... | ... |
| Communication with Cartagena and Barranquilla, Columbia. | May 22nd, 1896 ... | ... |
| Columbia landlines ... ... | June 4th, 1896 ... | June 17th, 1896. |
| Siberian landlines interrupted near Chabarowska | June 8th, 1896 ... | ... |
| Blagovestchensk - Vladivostock | June 13th, 1896 ... | June 19th, 1896. |
| Saigon-Bangkok ... ... | June 15th, 1896 ... | ... |
| Communication with San Juan, Boutista (Mexico), and places beyond. | June 23rd, 1896 ... | June 24th, 1896. |

June 20th.—Berne notifies telegrams for San José, and places beyond this town in Guatemala, are subject to censure.

**Prolongation of the French Cable System.**—We read that a well accredited rumour is current in Tangier that France intends to lay a telegraph cable between Tangier and the coast of France or a French possession, probably Oran; a continuation of the line from Tangier to Senegal will then render France independent of the Spanish landlines and cables in her communication with her West African colonies.

**Leeds Telephone Service.**—In view of the Leeds Corporation adopting the electrical system of tramway traction in the city, the National Telephone Company have decided to substitute their present overhead single telephone wires for double underground wires. A committee recommends the Council to agree to this.

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Australia.**—The Sydney correspondent of the *Financial News* says:—"A company, known as the North Sydney Electric Railway Company, Limited, is being got up here with a total capital of £350,000, of which £250,000 will be offered in England, and the remainder provided in the colony. I am not at liberty to mention at present the names of the London firm who have the matter in hand, inasmuch as several important details have yet to be completed before any public issue can take place." The scheme is being promoted by Mr. John Sulman. It is proposed to construct from the Post Office to a place called Milson's Point an electric railway which is estimated to cost, inclusive of all expenses for making a tunnel, lifts, land purchase, generating works, plant, rolling stock, and a certain amount reserved for working capital, the total sum of £350,000. A Bill for this line was brought before the New South Wales Parliament last Session, and reached Select Committee stage, and leave will be asked for its reintroduction this Session at the earliest possible date.

**Austria-Hungary.**—It is stated that a company in Geneva is preparing plans for a projected electric railway between Buda Pesth and Fiume.

**Belgium.**—Six offers were received by the Societé Nationale des Chemins de Fer Vicinaux in Brussels for the conversion into electric lines of several "vicinal" steam tramways in the centre district, the lowest being that of the Compagnie Générale de Traction et d'Electricité, of Paris, the next lowest being that of the Union Electrical Company (Thomson-Houston), of Berlin. The result of the adjudication will not be made known for about a month.

**Dover.**—The Town Council is taking advantage of the suspension of the standing orders, which prevented corporations working their own tramways, and in reply to a communication from the Board of Trade, the Town Clerk is to state that the Council would like to retain power to work the tramways.

**Dublin Extensions.**—The Dublin Southern District Tramways Bill, which provides for an extension of the electric tramways, was before the Select Committee of the Commons on Wednesday last week. Mr. Clifton Robinson, Mr. H. F. Parshall and others gave particulars.

We learn from the Dublin press that the Select Committee has decided that the preamble of the Bill has not been proved, and the scheme is consequently thrown out.

**Kidderminster and Stourport.**—This electric tramway Bill was before the examiners in the House of Lords on 19th inst., but all the necessary formal proofs not being forthcoming, it was decided that the Standing Orders had not been complied with, and the matter accordingly was referred to the Standing Orders Committee.

**South Africa.**—The *Cape Times* hears that the electric tramways authorised to be laid in Cape Town and its vicinity will run into a quarter of a million sterling. The metals represent a total length of 20 miles, and their weight is 80 lbs. to the yard—10 lbs. heavier than the metals in use on the Cape Government railways.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Austria.**—June 28th. The last date for the receipt of tenders invited by the Municipal authorities of Prague, for the erection and equipment of a municipal electricity generating station in the town for electric lighting, power, and tramway traction purposes, has been extended from June 1st to the 28th.

**Battersea.**—July 14th. The Vestry of St. Mary invites tenders for the supply and erection of boilers, engines, switchboards, accumulators, wiring and fittings, &c., &c., for lighting the Municipal Buildings and Town Hall electrically. Particulars from Robert Hammond, consulting engineer, Ormond House, Great Trinity Lane, E.C. For further details see our "Official Notices."

**France.**—July 2nd. Tenders are invited for the supply of 275 tons of bronze or copper wire. Address, the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

**France.**—July 11th. Tenders are invited for the supply of 25 kilometres of telegraph cable, containing six pairs of paper-insulated conductors. Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

**Germany.**—July 25th. Tenders are being invited for the supply and erection of the plant and fittings required for the electric lighting of the railway station at Bretten. Tenders to the General Direction of the Grossh-Badische Staats-Eisenbahnen, Carlsruhe.

**Jamaica.**—Electric tramway constructors willing to undertake the establishment and working of a system of rapid transit (electric) are invited to send in applications for the grant of a license by the Governor in Privy Council under the Tramways Law, 1895. All particulars, plans of the city of Kingston, &c., &c., may be seen at the office of the Crown Agents for the Colonies, Downing Street, London, S.W.

**Madras.**—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

**Mexico.**—August 31st. The Municipal Council of Mexico is inviting tenders for the concession for the electric lighting of the public streets during a period of eight years.

**Rochdale.**—June 30th. The Free Library Committee invites tenders for the electric lighting plant required at the library, consisting of gas engine, dynamo wiring, fittings, &c. Particulars at the office of Mr. Platt, the borough surveyor.

**Wallasey.**—July 16th. The District Council invites tenders for condensing apparatus and steam and exhaust pipes in connection with the electric lighting installation. For further details see our "Official Notices."

### CLOSED.

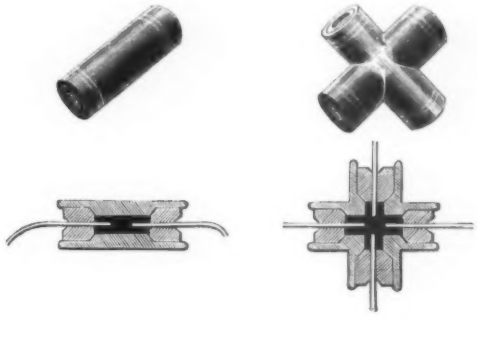
**Hanley.**—A steam boiler for the electricity works is being purchased from Mr. Edwin Danks, at a cost of £465. The extension buildings at the works is to be insured for £2,000.

**London.**—We understand that the tender of Messrs. J. F. Clarke & Sons for engineering and electric-lighting work at the new Public Baths and Washouses, Manor Place, Walworth Road, S.E., for the St. Mary Vestry, Newington, has been accepted, the total amount being £6,579.

## NOTES.

**Rotation of the Cathode Disc in a Crookes Tube.**—Prof. Francis E. Nipher (*Trans.* Acad. Science of St. Louis), describes a curious phenomenon which he has observed in a Crookes tube, which appears to show that the cathode discharge has a reaction on the cathode disc which causes it to rotate on its axis. This effect was discovered accidentally, owing to the cathode disc, in a tube which the author was using, having become loose on its wire. The direction of rotation was contrary to the hands of a clock, when the disc was viewed from the point where the cathode wire pierces the wall of the tube. No accelerating or retarding effect was produced by magnets on placing the tube in all possible positions in the magnetic field, which is contrary to what was to be expected, from the well-known fact that cathode rays tend to twist helically about the magnetic lines of force. On the other hand, a more decided rotation was produced by using the brush discharge of a 24-inch Holtz machine. It was necessary, however, to have short spark gaps between the terminals of the machine and those of the tube. When the loose disc was made the anode, no tendency to rotation was observed. Thus far, all attempts to produce the effect in air at the ordinary pressure have failed. The tendency to rotation is not shown till the vacuum in the tube approaches its highest limit. The anode wire was at right angles to the cathode wire in the tube experimented with, and till experiments with symmetrically arranged anodes are made to disprove it, we should be inclined to think that this circumstance has something to do with it.

**New Electrical Connector.**—The connector described below is designed to obviate some of the inconveniences of the ordinary connector. It consists, says the *Electrical World*, simply of an insulating material, and enclosing a core of conducting amalgam (Hg). It is cylindrical in form, and in each end is inserted a soft rubber stopper, having a small hole in its centre, through which a conducting wire can be inserted, thus making connection through the amalgam core.



It will be seen that the use of these articles must save a great amount of time in making connections for experimental purposes, as all that is necessary is to insert the conducting wires through the perforated stoppers, there being no screws to tighten. Since the exterior of the apparatus is of insulating material (hard rubber), there is no danger of a "short circuit" by the connectors coming in contact. This system is applied to reversing switches and various instruments, and is the invention of F. E. Austin.

**Not New.**—The *Western Electrician* describes in its June 6th issue the Nowotny arc lamp, which is stated to be of an entirely new type. Two of the main features of the lamp are the carbons placed parallel to each other throughout the entire length which is to be consumed by the arc, and the arc is kept at the tips of the carbons by the use of a magnetic field. We would like to point out that instead of being "entirely new," these two features are very ancient, as both methods were adopted in Jamin's lamp over here many years ago.

**Third Rail Tests on the Nantasket Beach Road.**—Electric traction by means of a third rail was thoroughly tested by officials of the New Haven road at the Nantasket power station recently. It is pretty definitely settled, says the New York *Electrical Engineer*, that the overhead system now in use on the Nantasket branch will be abandoned in favour of the third rail, and contracts have already been made for the equipment of part of the line. The trial was thoroughly satisfactory, and those who were present expressed themselves as being confident that the system will be successful. It was effectually demonstrated that great speed and efficiency could be obtained, fully as great, in fact, if not greater than, with the overhead system. The rail is alive for its whole length, and will be equipped with some protection similar to that in use on the Intramural Railway at Chicago. Each rail is mounted on three blocks of wood, which keep it from touching the ground. It is broad and flat, and has a flange at each edge which reaches down over the blocks of wood, giving a sort of inverted V shape to the whole, as seen end on. The application from the car is not made by a wheel, as in the overhead system, but by a shoe, which slides along the top of the rail. The blocks on which the rail rests are about 6 inches square, and 4½ inches high, the height of the whole structure being 6 inches from the trestle. The rails are coupled with copper bonds, which take the place of fish-plates on the ordinary rail, and are bolted to the flanges where they project over the blocks of wood. The whole structure projects about 1½ inches above the rails.

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**Mr. T. Commerford Martin's Lecture.**—Lord Kelvin presided, last Friday evening, at the address delivered before the Royal Institution, by Mr. T. C. Martin, of the New York *Electrical Engineer*, on the subject of "The Utilisation of Niagara." There was a large and distinguished assembly, including Sir Douglas Galton, M. Moissan, Sir F. Bramwell, &c. Mr. Martin said the problem was the utilisation of the energy of Niagara without impairing the beauty of the scenery. After describing the physical character of the Falls, he declared that it was possible to collect and transmit the enormous power of the falling water for a distance of 100 miles, and utilise it in drawing engines on railways, tramcars in streets, steamers on canals, for the lighting of towns, and for a dozen other purposes. At the present time, the greatest work accomplished was the construction of Evershed's Canal, which led the water through artificial cuttings, where it was made to yield the energy which it possessed, and this was distributed by electricity to all who required a cheap power for commercial undertakings, or for public purposes. The canal works, with all the complicated machinery for collecting the power from the water, were described by means of a lantern and a large number of slides specially taken for the purpose.

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**Still Room!**—We have seen it stated somewhere that there is always room for one more on a U.S. trolley car. That certainly seems to have been the case with a Brooklyn electric car a few weeks ago, for 132 passengers was not a sufficient load for the ambitious conductor. Perhaps he was trying his hand at record-breaking, for he admitted yet another, thus making a grand total of 133; and it is to be supposed that had not Providence intervened, he might have added further to it. But it was ordered otherwise, for this well-laden car ran backward down a hill for a third of a mile, killing a boy, fatally injuring a woman, seriously injuring six other passengers, and slighly injuring nearly two dozen others. It is not an uncommon occurrence for the police in this country to stop an overloaded car, make the standing passengers withdraw, and summons the conductor. Not so in America it seems. Oh, what a happy place is Brooklyn!

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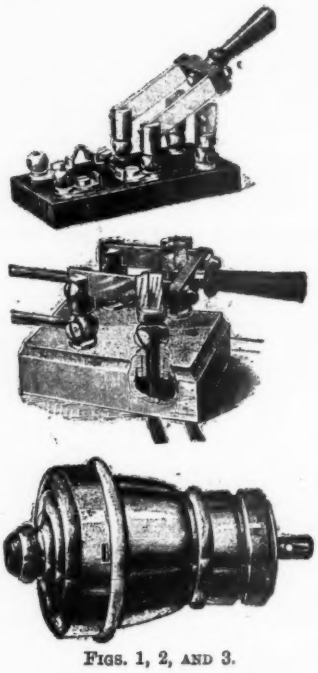
**Appointment.**—From the 41 applications received for the post of resident electrical engineer to the Shoreditch Vestry, Mr. R. F. Ferguson, of the Bankside station of the City of London Company, and formerly employed at the Brighton Corporation Electricity Supply Works, has been selected.

**American Specialities.**—From a transatlantic contemporary we derive the following particulars of baby switches and standard attachment plugs which Messrs. J. Jones and Sons, of New York, are placing upon the American market. Baby switches are made in sizes of 15, 25, and 35 amperes capacity. The 35-ampere switch shown in fig. 1 is made in double-pole, double-pole fused and double-pole, double-throw types, and is claimed to be the smallest switch on the market, carrying capacity considered. It is especially adapted for tablet-board work, switchboard work, or in



Figs. 1, 2, and 3.

situations where space is limited. The rating of this switch will allow of an overload of 20 per cent., and it is guaranteed to keep cool. It is mounted on a black, polished slate base 2½ × 5 inches, and has back connections for switchboard work. They are ornamental in design and well finished, and all styles are carried in stock. Ease of wiring, substantial construction, small space and low prices are the principal qualities that commend these switches to all interested. Fig. 2 shows the manner in which the wire connections are effected. The attachment plugs (Fig. 3) are made with all standard bases, and are easily wired.

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**Surely Not!**—We received a shock this week, and we trust those interested parties who had a similar surprise will survive, as we have. America—particularly the United States—is the land of hurry; we have heard that over and over again, and it is a truth which makes itself forcibly felt, especially in a cyclone. What so disturbed our equilibrium was the following announcement:—

Chicago Exhibition, 1893.

The medals and diplomas awarded to British exhibitors at Chicago have *at length* been issued to H.B.M. Ambassador at Washington, and have been transmitted by him to the Foreign Office. Sir Henry Trueman Wood has been requested by the Secretary of State to undertake the duty of distributing them, and this will be done at once. All the exhibitors may expect to receive their medals within about a month from the present date (June 17th).

The italics are ours. The length is nearly three years! British exhibitors at the celebrated show of 1893 should get up a testimonial to the authorities for presenting these awards so speedily.

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**Motor Carriages at Kensington.**—If any interested person desires to observe self-propelled vehicles in action, we could not conscientiously advise him to set any store upon what may be seen at the Imperial Institute. The track is simply a toy road, and about equivalent in length and difficulty to a country circus ring.

**International Telegraph Conference.**—On the 16th inst. the International Telegraph Conference of 1896 was opened in the Academy of Science at Budapest by M. Daniel, Minister of Commerce in Hungary. Mr. Fischer, the senior of the Government delegates present, delivered an excellent and eloquent address in reply, after which the Government delegates and the representatives of the several companies adjourned to the hall allotted to the conference meetings. The usual formalities were then gone through, and the three committees on rules, tariffs and editing were duly appointed. In addition to the work which has to be gone through, there has been arranged a series of entertainments which show Hungarian hospitality to be of a very thorough nature. The Government delegates and others attending the Conference were received with a personal kindness, for which they are greatly indebted. The Minister, M. Daniel, is prominent in this respect, and the President of the Conference, M. de Szalay, does everything that can be done for the guests of his country. M. de Szalay is ably seconded by Mr. Schrimpt and Mr. Dürr, and the other Hungarian delegates, among whom Dr. Henneyü and Mr. Balla are indefatigable. The ladies who have accompanied the delegates and the representatives owe a debt of gratitude to the kindly solicitude of Madame de Szalay, whose complete knowledge of the English and French idioms enables her to act to its full the part of a charming hostess. The English-speaking section attending the Conference are highly flattered in the fact that all the Hungarian delegates have a perfect knowledge of our language. As the proceedings of the Conference are of a private nature, and the public are not admitted to the meetings, we cannot at present give details of the discussions and determinations. This is to be regretted, as there are before the Conference the proposal of Germany to unify the rates in Europe, and the proposal of France to increase the number of characters allowed as the equivalent for one word in the charging under extra European rules. There is also the question, so much discussed in the press and by the Chambers of Commerce, of the enforced employment of an official vocabulary. It is believed, however, that of these three proposals, that of France is considered as the only one likely to pass the vote of the delegates.

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**Molybdenum Bronzes by Electrolysis.**—Amongst the future products of electrolysis at high temperatures, it seems probable that useful alloys may find a place; at any rate, electro-metallurgists are demonstrating the possibility of preparing many new compounds, some of which may turn out to be of considerable industrial utility. In the *Berichte*, Stavenhagen and Engels describe some molybdenum bronzes which they have recently succeeded in preparing. Amongst these, there is one which bears a great resemblance to tungsten bronze, and is formed by electrolysing fused acid, sodium molybdate. The fusion is performed in a platinum crucible, with a current of 8·5 amperes and generated by three accumulators (4·9 volts) placed in series. The bronze separates quickly at the cathode in crystals, which have to be washed with boiling water and dilute hydrochloric acid. It is soluble in alkalies, in nitric acid, and aqua regia, but not in hydrochloric or sulphuric acids; its composition is found by analysis to correspond to the formula, $N_2 Mo_8 O_{15}$. For further details, consult the original paper in the *Berichte der Deutschen Chemischen Gesellschaft*, xxviii., page 2280.

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**Competition.**—The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw trust, a gold medal, or a prize of £20, "For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than December 31st, 1896, to the secretary of the Society of Arts, Adelphi, London, W.C.

**Electrotechnical Institute at Carlsruhe.**—The Baden Chamber has voted £30,000 to the Technical High School at Carlsruhe to build a new electrotechnical institute. The erection of a special building for the Institute has been a matter of pressing necessity, since the formation of a special electrotechnical department, and the nomination of Prof. Arnold in 1894. The designs have been worked out by Dr. Worth, in conjunction with Prof. Arnold. The ground plan of the building is a square, 40 m. a side, in the centre of which is a court or quadrangle, 14 by 17 m. The building contains underground, ground, and upper floors, with the exception of the back cross building, where the underground and ground floors are united to form a lofty machine room, on the short side of which are the switch room, workshop, storeroom, and gas engine room. Over the machine room, in the upper storey, is a large construction room. The upper storey also contains two lecture rooms, tutors' rooms, and besides the aforesaid construction room, several training rooms. The training rooms are to be made of very great size, since exercise in practical construction in the field of dynamo building, &c., and exercise in the design of central stations and distribution networks are considered to be of the greatest importance. The ground floor is occupied by laboratories for regular practice in measurements of resistance, current, potential, capacity, induction, and allied measurements. In the basement there are laboratories for photometry, high tension and cable investigations, accumulator room, and store room. The whole cost of the building, exclusive of the cost of the land, is estimated to be about £25,000. The building is to be commenced immediately, and it is expected that it will be ready for occupation in two years.

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**Electrical Conductivity of Salts Dissolved in Glycerol.**—Carlo Cattaneo has, during the last two or three years, devoted a considerable amount of attention to the investigation of electrical conductivity of salts dissolved in various solvents, for example, water, alcohol, and ether. He has now turned his attention to the conductivities of solutions of ammonium, sodium, zinc, barium, and ferric chlorides, and potassium bromide, and iodide in glycerol containing 25 per cent of water at various temperatures between 0° and 24° Centigrade. The conductivity of the various salts is, in general, greater than that of the corresponding ethereal solutions, but less than that of the alcoholic ones; the conductivity of the aqueous, alcoholic, and glycerol solutions increases more rapidly than the concentration. As the concentration decreases, the molecular conductivity of the salts in aqueous solution increases, and in ethereal solution decreases; that of the chlorides increases, whilst that of the bromides and iodides decreases, in alcohol solution, and in glycerol, the molecular conductivity of the chlorides increases, whilst the concentration decreases. The temperature coefficients are usually greater for aqueous than for alcoholic solutions; in ether, they are of approximately the same order as in water, but are negative in sign, whilst, in glycerol, the temperature coefficients have very high values. In his paper, which may be consulted in the *Real. Accad. Lincei*, 2, p. 112, Cattaneo gives a table of the conductivities of the glycerol used at various temperatures, showing that it obeys the rule enunciated by Bartoli, which states that those carbon compounds which become most viscous on cooling, are those whose conductivity increases most rapidly as the temperature rises. At 18°, the conductivity of the glycerol was found to be of the order of $10^{-12}$.

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**New Journal.**—We have received a copy of the first number of a new monthly Italian journal, known as *L'Illuminazione*, which is devoted to various systems of illumination, such as electricity, gas, mineral oils, &c. A special supplement is issued with each number, that for May being devoted to acetylene gas and its applications.

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**The Institution of Electrical Engineers.**—Last night, the annual conversazione was held in the galleries of the Royal Institute of Water Colours, Piccadilly, invitations having been issued by Dr. John Hopkinson, the President, and the Council.

**London County Council and the Tramways.**—Readers of the ELECTRICAL REVIEW will have been prepared for the announcement that at their meeting on Tuesday the London County Council endorsed, without discussion, the recommendation of the Highways Committee that the proposals of the County of London Tramways Syndicate should not be accepted. The further recommendation of the Committee that an arrangement should be made for leasing certain lines to the North Metropolitan Company was referred back to them, with instructions to report as to the probable profit to be obtained by the Council itself working such portion of the Northern system as will be within its control after 1898, information being given on the basis of horse traction, and also electric traction or other approved mechanical means. By a thorough investigation into the results of electric traction, and an intention not to limit the scope of inquiry to conduit systems, the Committee should be able to make such a report to the Council as would ensure the adoption of electric traction in London at an early date.

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**American v. European Shop Practice.**—An article in *Cassier's Magazine* by R. M. Grimshaw, raises the question of apprenticeship. Curiously enough for an American, the author allows that the average American workman is not so "handy" as the European. This is a big admission to make. The unhandiness is attributed to the lack of the apprenticeship system, caused by labour unions interfering. Probably the truer cause is the objection of young America to manual trades. In some way or other, apart from handiness, Americans get along very well with such materials as they have. No doubt there is a very large European element of skilled men among them, and the tendency has been all in the direction of machinery, and of duplication, and of skimping material. The result is that in small work it would be impossible to beat American goods at the price. They are handy anyhow, whatever the American workman may be; they are well designed, and they are not clumsy, because, in small tools, one cannot use too little material and get a good appearance, so that such things as callipers, squares, &c., hold the field. That they are not more accurate, it so accurate as the highest class of English goods has been urged against them, but they are so nearly accurate that they will do better than anything else a workman can buy, and cheap enough to remove the tendency to make a "foreign order" for himself, as is the way in most old shops where an apprentice's first business is to make unto himself articles of iron and of brass, and so on.

When Mr. Grimshaw states, however, that it is only a few European shops of 5,000 men and upwards who have plate bending and flanging machines, and many others have riveting machines for boiler work, he must be dreaming. English boiler making, at any rate, is far in advance of anything done in America, and the production of boilers in America, though large, is very much in the line of very simple cylinders with a few tubes and stays. We know, as a fact, that the lack of properly trained men is felt in America as it is here. The workman is deficient in skill, and the deficiency is felt where operations cannot be all machine effected, and the more specialised things become, the greater will be this difficulty.

Apprentices are now much less taken than they were, or, perhaps, it is that they are not needed. It is hardly possible to train up a reasonable proportion of apprentices at a works where everything is machine fitted. The time to be spent on genuine hand work is too little as compared with the time watching a machine tool, and workmen are rapidly drifting into two classes—machine minders and erectors. The technical school affords the well-to-do youth his opportunity of learning workshop operations to a certain extent, if he can discern what is merely scholastic in the methods by occasional visits to some good shops, but of such youths none of them aim at the position of a simple workman, and either attain to what they think better, or drop out. Fortunately, there are repair shops, and it is to these that we must look for the supply of skilled men who can do the class of work that machine minding will never teach; but, after all is said, is not the demand for such men less than formerly? Skilled men to erect steam engines are not now much required, because engines are all in a piece where once they were in separate parts and had to be arranged on a foundation, and the same tendency is visible in every direction. The accuracy with which machines are made may be taken as evidence that in some way the difficulties as to skilled workers are less real than one supposes.

Perhaps it is hardly fair to call in the plumber as an example of the degradation of the worker, for he has been "an hissing and a reproach" for long years before the outcry arose of bad workmen, and he remains to-day much as he ever was. But the difficulty with the plumber is a moral one. He deals in materials having no backbone themselves and it must require a strong character not to resist the temptation to make one's materials bend to fits and places. The use of soft lead and yielding putty cannot fail to weaken the moral fibre of the workman. Hence the frailties of the plumber, who ought to be rather pitied. He compares badly with the smith, and the carpenter again scores as against the bricklayer who uses mortar, but the bricklayer is not so lost as the plumber, because his work as a whole must be straight and plumb.

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**Recovery of Tin from Scrap Metal.**—"Mr. Swinburne, of London, in a recent lecture stated," says an exchange, "that it was easy enough to recover tin from scrap electrolytically in a solution of hot caustic, but the difficulty was to find the scrap from which to skin the tin, as no one seemed to have any for sale." We are rather surprised to hear this from Mr. Swinburne, for a few years ago, when engaged for a considerable time in recovering tin electrolytically from scrap, many tons of scrap could be had for the mere asking, but the tin was never recovered in a way to make the working commercially successful.

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**The Institution of Junior Engineers.**—Last night (Thursday) a visit was paid to the engineering works of Messrs. Bryan Donkin & Co., Southwark Park Road, Bermondsey, S.E. A special summer London-district excursion has been arranged for Saturday afternoon, July 25th. It is to take the form of a steamer trip to visit H.M.S. *Sans Pareil*, armoured battleship, lying off Sheerness, at the mouth of the Thames. The steamer, *Clacton Belle*, has been engaged for the exclusive use of the Institution. The summer meeting will be held in Scotland.

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**Leeds Tramways.**—There were a great number (about 70) of tenders sent in for the electric tramway plant required by the Corporation. It is expected the work will cost getting on for £100,000. We understand that the committee having the matter in hand have experienced considerable difficulty in comparing the various tenders. They still have the matter under consideration.

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**Postal Telegraphs.**—We understand that Mr. G. Noble Partridge, Assistant Superintending Engineer, Nottingham, has been appointed Superintending Engineer, Cardiff, in the place of the late Mr. H. J. Vose. Mr. G. M. Carr, Assistant-Superintending Engineer, Newcastle, has been appointed Superintending Engineer, Leeds, in the place of Mr. J. C. Chambers, retired.

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**Electric Clocks.**—There is a proposal to place all the public clocks in the city of Edinburgh under electrical control from the City Observatory.

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**Electricity Meters.**—A long letter has just come in on this subject, but too late for publication this week.

**The Dielectric Constant.**—An interesting research has recently been conducted by F. Ratz upon the dependence of the dielectric constant on temperature and pressure. He appears to have followed the well known method of Nernst which was first published in 1894. The constant was determined at various temperatures and pressures in the case of benzene, toluene, carbon bisulphide, ethylic ether, chloroform, aniline, amylic alcohol, ethylic alcohol, and water. The value $(D - 1)/(D + 2)d$ is a function of both temperature and pressure, the temperature coefficient increasing with the dielectric constant. The variation between the values of the constant obtained from the formula and the actual number is, for a temperature of 30°, below 10 per cent., and the value of the above expression within 40° changes by less than 5 per cent. The temperature coefficient is small, and in all cases negative, decreasing slightly as the temperature rises. No maximum for D is found at 4 in the case of water, and if such exists at all, it must be between 0° and 1°. In all cases the value of D is greater than $\mu^2$ obtained from refraction observations. The pressure coefficient is small and positive, so that it follows that the influence of temperature is greater, and that of pressure less, than the calculated effect. Details of the method, the purification of the compounds examined, and the experimental numbers, are given in the paper, which may be consulted in the *Zeitschrift für Physikalische Chemie*, 1896, Vol. xix., pp. 94—112.

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**A Method of Determining Mercury in its Ores.**—In the *Journal* of the American Chemical Society there is a short paper in the joint authorship of W. B. Rising and V. Lenher, describing an electrolytic method for determining mercury in cinnabar. The mercuric sulphide is treated with hydrobromic acid, in which it dissolves very readily; the solution is nearly neutralised with caustic potash, pure potassium cyanide added in sufficient excess to redissolve the precipitate which is at first formed, and the solution is electrolysed by means of a weak current; the operation is carried out in a platinum dish, which acts as the negative electrode, and on this the mercury becomes deposited. The advantage of hydrobromic acid over aqua regia is, that it dissolves cinnabar at low temperatures, so that no loss of mercury by volatilisation occurs. Results are given showing the accuracy attainable. For further details, consult the *Journal of the American Chemical Society*, 1896, Vol. xviii., pages 96—98.

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**Electrolytic Estimation of the Halogens.**—George Vortmann described, a short time ago, a method for the electrolytic estimation of iodine, and he now calls attention to several important improvements in the process. An anode of pure silver, shaped like a clock-glass, a cathode of platinum or copper, and a current which does not exceed 2 volts in the case of cold solutions containing no alkali tartrate, or 13 volts when the solution is warm and contains alkali, tartrates are employed. The electrolysis is continued until the solution no longer gives the iodine reaction, or until a new anode placed in the solution does not gain in weight. Under these conditions, no silver is dissolved from the anode, which retains on its surface the whole of the iodine in the form of silver iodide. For further details, consult the *Monatschefte*, xvi., pp. 674—683.

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**Electro-Capillary Properties of Dilute Sulphuric Acid.**—A. Gouy has recently made a number of determinations of the relationship between the height, $h$, of the column of mercury balanced by electro-capillary forces, and the difference of potential, v, between the mercury and the electrolyte, using solutions of sulphuric acid of various concentrations as the electrolyte. The values of $h$ decrease with the concentration of the solution, but, in the more concentrated solutions, exact measurements become impossible, owing to the occurrence of electrolysis. The second derived function, $d^2 h/d v^2$, is always negative, so that the curve of $h$ has no point of inflexion, and does not tend to any limiting value. The actual value of the function is not constant, but is subject to complex variation.

**Lecturers Wanted.**—Three lecturers are wanted for the Borough of Swansea, under the scheme for intermediate and technical education. They are as follows:—1. Lecturer in metallurgy and chemistry. 2. Lecturer in physics. 3. Lecturer in engineering. The salary in each case is £200, rising to £250 per annum. Particulars from Principal G. S. Turpin, M.A., D.Sc. Applications must be sent in by July 4th.

The Brighton Committee of Management invite applications for the appointment of temporary lecturer and instructor in applied electricity and physical sciences for two days per week, the salary being £80 per annum. Applications to be sent by July 7th to the Town Clerk, Town Hall, Brighton. For particulars see our "Official Notices."

The Governing Body of Battersea Polytechnic require the services of a workshop instructor in house wiring and jointing. For particulars see our "Official Notices."

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**Gas Accident.**—A terrible gas explosion which occurred on Wednesday morning at 5, Plough Road, Battersea, wrecked the premises, and injured one man severely and two others slightly, in addition to setting fire to the place.

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## NEW COMPANIES REGISTERED.

**Llandrindod Wells Electric Light and Power Company, Limited** (48,340).—This company was registered on June 15th with a capital of £5,000 in £5 shares, to carry on the business of electric lighting in all its branches in the urban district of Llandrindod Wells, in the county of Radnor. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, £50. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, Manchester House, High Street, Builth, Co. Brecon.

**Auto-Electro Feed-Water Purifier Company, Limited** (48,361).—This company was registered on June 16th with a capital of £10,000, in £5 shares, to acquire, develop, and turn to account British patent No. 7,435, of 1893, for the purification of the feed-water of steam boilers, and to adopt an agreement with T. C. Jones. The subscribers (with one share each) are:—M. Walker, Wolverhampton, gentleman; T. C. Jones, Wolverhampton, gentleman; C. A. Newnham, Wolverhampton, surgeon; J. Underhill, Wolverhampton, stockbroker; W. W. Walker, Wolverhampton, merchant; E. Dixon, Wolverhampton, gentleman; E. K. Mitting, Wolverhampton, chemist. The number of directors is not to be less than three, nor more than six; qualification, £100; remuneration, £150 per annum, divisible. Registered by Taylor & Co., 12, Norfolk Street, Strand.

**Denayrouze Light Syndicate, Limited** (48,384).—This company was registered on June 17th with a capital of £25,000 in £1 shares, to adopt an agreement with Albert Vickers and Basil Zaharoff, and to carry on the business of manufacturers and dealers in apparatus of all kinds for increasing the illuminating power of gas, spirits, oil, and other light producing agents, suppliers of light, heat, electricity, and motive power, electricians, chemists, engineers, &c. The subscribers (with one share each) are:—T. G. Osborn, 33, King's Road, Peckham, clerk; E. D. Lane, 34, Mallinson Road, New Wandsworth, clerk; H. J. Morris, 48, Pepys Road, New Cross, S.E., clerk; F. E. Hinton, 2, Zetland Terrace, Old Charlton, clerk; J. T. Coffin, 188, Leander Road, Brixton Hill, clerk; G. Sherriff, 44, Denmark Road, Denmark Hill, clerk; C. A. Searle, 79, Horder Road, Fulham, clerk. The number of directors is not to be less than two nor more than five. Registered by Littledale & Lefroy, 7, King's Bench Walk, Temple.

**Electrical Manufacturers, Limited** (48,418).—This company was registered on June 19th with a capital of £5,000, in £1 shares, to acquire, take over, and carry on the business of a dealer in electrical apparatus, electrician, and electrical engineer, carried on by H. E. Childs at 223, Upper Thames Street, E.C., and to adopt an agreement with the said vendor. The subscribers are: O. T. Dorme, 6, Milner Street, N., electrician, 25 shares; E. J. Coste, Bank Street, Gravesend, broker, 25 shares; T. F. Moss, Surrey Wire Mills, Rotherhithe, manufacturer, 100 shares; E. G. Richmond, 22, St. John's Hill, S.W., electrical engineer, 50 shares; H. Findley, 518, West Green Road, Tottenham, journalist, 50 shares; E. R. Ward, Lower Richmond Road, Putney, gentleman, 50 shares; E. Mezzadrey, 13, Panton Street, Haymarket, hotel proprietor, 25 shares. The number of directors is not to be less than two, nor more than five; qualification, £100; remuneration, £50 per annum, and a share in the profits divisible. Registered office, 223, Upper Thames Street, E.C.

**British Electrical and Industries Company, Limited** (48,402).—This company was registered on June 18th with a capital of £100, in £1 shares, to acquire and carry on businesses relating to the working of electricity in all its branches, and to carry on the business of a supply stores. The subscribers (with one share each) are:—F. Smerdon, 13, Marnock Road, Crofton Park, S.E., accountant; W. A. Lessing, 225, Winchester House, E.C., gentleman; R. Mein, 79, Stacey Road, Cardiff, engineer; S. A Glover, The Park, Southend, clerk; J. W. Dykes, 4, Melbourne Road, Walthamstow; C. T. G. Engholm, 3, Tremadoc Road, Clapham, clerk; W. E. Clark, 24, Waldemar Avenue, Putney Bridge, clerk. Table "A" mainly applies. Registered by Faithfull & Owen, 11, Victoria Street, S.W.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Woking Electric Supply Company, Limited** (46,175).—This company's annual return was filed on June 5th. 15,009 shares have been taken up ont of a capital of £20,000 in £1 shares, and all have been considered as paid.

**Windermere and District Electricity Supply Company, Limited** (41,461). This company's annual return was filed on May 29th. The capital is £50,000 in £5 shares, and 307 have been taken up. £1 per share has been called on 7, and nothing on £300, and £7 has been paid.

**Woolwich District Electric Light Company, Limited** (31,814).—This company's annual return was filed on March 27th. 9,250 shares have been taken up out of a capital of £10,000, in £1 shares, and 668 have been issued as fully paid; £1 per share has been called on 8,582, and £8,410 has been paid, leaving £172 in arrears.

**Brazilian Submarine Telegraph Company, Limited** (6,886).—This company's annual return was filed on June 3rd. The whole capital of £1,300,000 in £10 shares has been taken up, and the full amount has been called and paid.

## CITY NOTES.

### Metropolitan Electric Supply Company, Limited.

An extraordinary general meeting of the Metropolitan Electric Supply Company, Limited, was held on Tuesday at Winchester House, Old Broad Street, E.C., under the presidency of Sir Eyre M. Shaw, K.C.B., to consider a proposal to increase the capital of the company.

The Chairman said: The remarks which I made to you in the course of moving the adoption of the report at the last general meeting will have prepared you for the notice which you have recently received, and upon which this extraordinary meeting is summoned. You will, no doubt, remember that I then stated that our chief engineer, Mr. Frank Bailey, laid before us, some months ago, his estimates of our probable requirements up to the year 1900. These estimates refer to the new works which are rendered necessary by reason of the most satisfactory manner in which the demand for electric lighting is being maintained. This increase is not only gratifying in that it is large, but I would specially point out that it does not come by fits and starts, but continuously, as if it were obeying some law of demand upon the maintenance of which we can rely with some confidence, and which has been the main factor in enabling us to make our calculations for the future. In addition to this normal progress to which we can look forward as practically assured, I ought, also, to remind you of the reduction in our rates of charge which we have felt ourselves justified in making to certain classes of our customers. We have every reason to believe that this concession will be a great boon to a large number of customers, especially smaller tradespeople, whom, owing to the regularity of their burning hours, we can supply economically, and to whom we are therefore able to offer our lowest current rates. The increase in our lamp density in many portions of our district also warrants our commencing the work of re-arranging our system of supply by the creation of transformer sub-stations. I need hardly point out that from the very commencement of our working the formation of these sub-stations has been kept in view, but so long as the demand was scattered it would have been impossible to arrange a supply on this system economically. Moreover, the experience which has been gained by other companies in the last few years through the working of these sub-stations has demonstrated that our caution in dealing with this matter was not misplaced. Special appliances, such as large transformers and concentric mains, with the necessary connections, are requisite for the work, and it has taken some time to bring their manufacture to the present state of perfection. We can, therefore, confidently look forward to obtaining the best results with absolute certainty, and with a much smaller capital expenditure than would have been the case had we embarked on this undertaking during its experimental stages. In carrying out this development, the directors wish you clearly to understand that the work which has been carried out up to the present time has not only fulfilled its purpose of maintaining our supply during what may be termed the pioneering period of the company's history, but the methods then adopted now enable us to carry out the new work with the greatest facility, and with the complete utilisation of our past expenditure. It will be at once obvious to you that to carry out these works on the most economical basis, it will be necessary to construct them to meet the demands of the company as they arise from time to time, and to be in a position to take advantage of the most favourable time for making contracts for new machinery and materials. The resolution which we now ask you to pass authorises the increase of the share capital of the company to £1,000,000, by the creation of 50,000 new shares of £10 each, and for the reasons which I have just given you, we ask you to leave it to your directors to issue such new capital at such times and in such amounts as the exigencies of the company shall seem to demand. We also ask you to leave to the discretion of your board the best method of placing the various issues on the market, feeling sure that you will credit them with the intention of furthering the best interests of the shareholders. I ought to add that it was only after the fullest consideration, and after consultation with those best able to advise us, that we came to the conclusion that, in the interests of the company, the capital required could be more advantageously raised by the creation of share capital than by any other method. So few weeks have now elapsed since I last had the pleasure of meeting you, that we have not much additional information to impart as to our present position; but I am happy to inform you that the revenue for the first quarter of the present year amounted to £38,616, as against £31,201 for the corresponding quarter in 1895, or an increase of 23 per cent. The number of lamps connected to our system, which, on the date of the last report, namely, March 17th last, was 272,000, now amounts to 285,000. Before I move the resolution, I should like to refer to certain letters which we have received from some of our original shareholders, inquiring what benefits they will receive in the new issues. Now, while I am most anxious to assure our original shareholders that the board fully realise how much is due to them, I feel sure that they will understand that it would be manifestly inexpedient, even if it were possible, for me to tell them the precise terms upon which the first or any subsequent issue of this new capital will be made. The conditions under which these issues will be brought out will quite possibly vary to meet the conditions of the market at the time, and I ask, therefore, those gentlemen who have been kind enough to write to us, to accept our assurance that, so far as it is conveniently possible, the interests of the shareholders of the existing capital of the company shall receive our first and best consideration. I now beg to move the following resolution:—"That the capital of the company be and is hereby increased to £1,000,000, by the creation of 50,000 new shares of £10 each."

After some discussion, Mr. Newton moved as an amendment that it be a recommendation to the directors to issue the new shares at par to the existing shareholders.

The Chairman said he could not accept the amendment, because at an extraordinary general meeting nothing could be taken except that which was actually printed in the notice. The proposition could only be negatived.

After some further discussion, the resolution was put and carried, and the proceedings then terminated.

**Stock Exchange Settlements.**—The Stock Exchange Committee has appointed Thursday, June 25th, as a special settling day in Brush Electrical Engineering Company, Limited—£76,770 4½ per cent. second debenture stock, and ordered same to be quoted in the Official List. Also to be quoted in the Official List—National Telephone Company, Limited, further issue of £229,471 3½ per cent. debenture stock.

**Brazilian Submarine Telegraph Company, Limited.**—The coupons on this company's second issue of 5 per cent. debentures, due 30th inst., will be paid on and after that date at Parr's Banking Company and the Alliance Bank, Limited, Bartholomew Lane, London, E.C. Coupons must be left at the above bank three clear days for examination.

**National Telephone Company, Limited.**—The transfer books of the 3½ per cent. debenture stock will be closed from the 22nd to the 30th inst., inclusive, for the preparation of the warrants for the half-year's interest due July 1st.

**Anglo-Portuguese Telephone Company, Limited.**—Coupons No. 17 of the first mortgage, and No. 12 of the second mortgage debentures will be paid, less income-tax, by Parr's Alliance Bank on and after 1st prox.

## TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 21st, 1896, were £836; week ending June 23rd, 1895, £794; increase, £42; total receipts for half-year, 1896, £23,178; corresponding period, 1895, £23,093; increase, £85.

The Liverpool Overhead Railway Company. The receipts for the week ending June 21st 1896, amounted to £1,221; corresponding week last year, £1,245; decrease, £24.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 19th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited were £2,900.

# SHARE LIST OF ELECTRICAL COMPANIES.

## TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | Name. | Stock or Share. ‡ | Dividends for the last three years. 1893. | 1894. | 1895. | Closing Quotation June 17th. | Closing Quotation, June 24th. | Business done during week ended June 24th, 1896. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 173,400£ | African Direct Teleg., Ltd., 4 % Deb. | 100 | 4 % | 4 % | 4 % | 100 —104 | 101 —105 | 101½ | ... |
| 25,000 | Amason Telegraph, Limited, shares | 10 | ... | ... | ... | 10 — 11 | 10 — 11 | ... | ... |
| 1,012,880£ | Anglo-American Teleg., Ltd. | Stock | £2 11s. | £2 2s. | £2 9s. | 47 — 49 | 47 — 49 | ... | ... |
| 2,993,560£ | Do. do. 6 % Pref. | Stock | £5 2s. | £4 4s. | £4 18s. | 92 — 93 | 92 — 93 | 93½ | 92 |
| 2,993,560£ | Do. do. Defd. | Stock | ... | ... | ... | 8¾— 9¼ | 9 — 9⅛ | 9⅞ | 9 |
| 130,000 | Brazilian Submarine Teleg., Ltd. | 10 | 6½% § | 7 % | ... | 15 — 15½ | 15 — 15½ | 15½ | 15⅝ |
| 75,000£ | Do. do. 5 %, Debs., 2nd series, 1906 | 100 | 5 % | 5 % | ... | 113 —117 | 113 —117 | ... | ... |
| 44,000 | Chili Telep., Ltd., Nos. 1 to 44,000 | 5 | ... § | 2½% | ... | 3 — 3½ | 3½ — 3⅝ | ... | ... |
| 10,000,000$ | Commercial Cable Co. | $100 | 7 % | 7 % | 7 % | 160 —170 | 160 —170 | ... | ... |
| 224,850 | Consolidated Telep. Const. and Main., Ltd. | 10/- | 2 % § | 1½% | ... | ⅞— 1⅛ | ⅞— 1⅛ | ... | ... |
| 16,000 | Cuba Teleg., Ltd. | 10 | 8 % | 8 % | 8 % | 12 — 13 | 12½ — 13½ | ... | ... |
| 6,000 | Do. 10 % Pref. | 10 | 10 % | 10 % | 10 % | 19½— 20½ | 19½ — 20½ | ... | ... |
| 12,931 | Direct Spanish Teleg., Ltd. | 5 | 4 % | 4 % | 4 % | 4 — 5 | 3½ — 4½ | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. | 5 | 10 % | 10 % | 10 % | 10 — 10½ | 10 — 10½ | ... | ... |
| 30,000£ | Do. do. 4½ % Debs. Nos. 1 to 6,000 | 50 | ... | 4½% | 4½% | 107 —110 % | 108 —111 % | ... | ... |
| 60,710 | Direct United States Cable, Ltd. | 20 | 2½% § | 2 % | ... | 9½— 10 | 9⅝— 10¼ | 10 | ... |
| 400,000 | Eastern Teleg., Ltd., Nos. 1 to 400,000 | 10 | 6½% § | 6½% | ... | 17 — 17½ | 17 — 17½ | 17⅝ | 17 3/16 |
| 70,000 | Do. 6 % Cum. Pref. | 10 | 6 % § | 6 % | ... | 18¼— 18⅝ | 18¼ — 18⅝ | 18 11/16 | 18 3/16 |
| 102,100£ | Do. 5 % Debs., repay. August, 1899 | 100 | 5 % | 5 % | ... | 106 —109 | 106 —109 | ... | ... |
| 1,297,837£ | Do. 4 % Mort. Deb. Stock Red. | Stock | 4 % | 4 % | ... | 131 —134 | 131 —134 | ... | ... |
| 250,000 | Eastern Extension, Australasia and China Teleg., Ltd. | 10 | 7 % | 7 % | 7 % | 17½ — 18 | 17½ — 18 | 17⅞ | 17 11/16 |
| 54,100£ | Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 | 100 | 5 % | 5 % | 5 % | 101 —105 | 101 —105 | ... | ... |
| 194,300£ | Do. do. Bearer, 1,050—3,975 and 4,327—6,400 | 100 | 5 % | 5 % | 5 % | 102 —105 | 102 —105 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock | Stock | 4 % | 4 % | 4 % | 132 —135 | 132 —135 | ... | ... |
| 80,600£ | Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | 5 % | 5 % | 101 —105 | 101 —105 | ... | ... |
| 107,600£ | Do. do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | 5 % | 5 % | 102 —105 | 102 —105 | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909 | 100 | 4 % | 4 % | 4 % | 105 —108 | 105 —108 | ... | ... |
| 200,000£ | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | 4 % | 4 % | 4 % | 110 —113 % | 110 —113 % | ... | ... |
| 180,227 | Globe Telegraph and Trust, Ltd. | 10 | 4½% § | 4½% | ... | 10¼— 11 | 10¼— 11 | 10⅜ | 10¼ |
| 180,042 | Do. do. 6 % Pref. | 10 | 6 % § | 6 % | ... | 17 — 17½ | 17 — 17½ | 17⅜ | 17 1/16 |
| 150,000 | Great Northern Teleg. Company of Copenhagen | 10 | 8⅝% | 8⅝% | 10 % | 23½ — 24½ | 23½— 24½ | ... | ... |
| 180,000£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 17,000 | Indo-European Teleg., Ltd. | 25 | 10 % | 10 % | 10 % | 52 — 55 | 52 — 55 | ... | ... |
| 100,000£ | London Platino-Brazilian Teleg., Ltd. 6 % Debs. | 100 | 6 % | 6 % | 6 % | 110 —113 | 110 —113 | ... | ... |
| 28,000 | Montevideo Telephone 6% Pref., Nos. 1 to 28,000 | 5 | 4 % | 4 % | ... | 2 — 2½ | 2 — 2⅛ | ... | ... |
| 484,597 | National Teleph., Ltd., 1 to 484,597 | 5 | 5 % § | 5 % | 5¼% | 7⅛— 7⅜ | 7⅛— 7⅜ | 7⅜ | 7 11/16 |
| 15,000 | Do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 16 — 18 | 17 — 19 | ... | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 16½ — 17½ | 16½ — 17½ | ... | ... |
| 119,234 | Do. 5 % Non-cum. 3rd Pref., 1 to 119,234 | 5 | 5 % | 5 % | 5 % | 6⅞— 7 | 6⅞— 7 | 6 15/16 | ... |
| 1,100,000£ | Do. 3½ % Deb. Stock Red. | Stock | 3½% | 3½% | 3½% | 107 —110 | 107 —110 | 109½ | 108⅝ |
| 171,504 | Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid | 1 | ... | 4½% | 5 % | 3/16— 1/8 | ⅛— 3/16 | ... | ... |
| 100,000£ | Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000 | 100 | 4 % | 4 % | 4 % | 108 — 111 | 108 —111 | ... | ... |
| 11,839 | Reuter's Ltd. | 8 | 0 % | *nil* | 5 % | 6½— 7½ | 6½— 7½ | 7 7/16 | ... |
| 3,381 | Submarine Cables Trust | Cert. | ... | ... | ... | 135 —140 | 135 —140 | 138 | ... |
| 58,000 | United River Plate Teleph., Ltd. | 5 | ... | 3 % | ... | 3½— 4 | 3½— 4 | ... | ... |
| 146,733£ | Do. do. 5 % Debs. | Stock | 5 % | 5 % | ... | 100 —105 | 100 —105 | ... | ... |
| 15,609 | West African Teleg., Ltd., 7,501 to 23,109 | 10 | *nil* | *nil* | 4 % | 7 — 8 | 7 — 8 | ... | ... |
| 238,300£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5 % | 103 —106 | 103 —106 | 103⅜ | ... |
| 30,000 | West Coast of America Teleg., Ltd. | 10 | *nil* | *nil* | *nil* | 1 — 2 | 1 — 2 | ... | ... |
| 150,000£ | Do. do. do. 8 % Debs., repay. 1902 | 100 | 8 % | 8 % | 8 % | 102 —107 | 102 — 107 | ... | ... |
| 64,248 | Western and Brazilian Teleg., Ltd. | 15 | 2½% | 3 % | 3 % | 9½— 9⅝ | 9 — 9½ | 9½ | ... |
| 33,129 | Do. do. do. 5 % Pref. Ord. | 7½ | 5 % | 5 % | 5 % | 6⅝— 7½ | 6⅝— 7½ | ... | ... |
| 33,129 | Do. do. do. Def. Ord. | 7½ | ... | 1 % | 1 % | 2½— 3 | 2½— 3 | 2 11/16 | ... |
| 165,200£ | Do. do. do. 6 % Debs. "A," 1880 Red. | 100 | 6 % | 6 % | 6 % | 105 —109 | 105 —109 | ... | ... |
| 206,400£ | Do. do. do. do "B," do. | 100 | 6 % | 6 % | 6 % | 105 —109 | 105 —109 | ... | ... |
| 88,321 | West India and Panama Teleg., Ltd. | 10 | ⅞% | 1% | ⅞% | 1 — 1½ | 1 — 1½ | ... | ... |
| 34,563 | Do. do. do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 11½— 11⅝ | 11½ — 11⅝ | 11½ | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 9½— 10½ | 9½— 10½ | ... | ... |
| 80,000£ | Do. do. 5 % Debs. No. 1 to 1,800 | 100 | 5 % | 5 % | 5 % | 109 —112 | 109 —112 | ... | ... |
| 1,777,000$ | Western Union of U. S. Teleg., 7 % 1st Mort. Bonds | $1000 | 7 % | 7 % | 7 % | 110 —115 | 110 —115 | ... | ... |
| 164,300£ | Do. do. 6 % Ster. Bonds | 100 | 6 % | 6 % | 6 % | 102 —105 | 102 —105 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electy. Supply | 5 | 4½% | 4½% | 5 % | 8½— 8⅝ | 8½— 8⅝ | 8⅝ | 8⅝ |
| 10,277 | *Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 | 5 | 5 % | 5 % | 5 % | 7⅞— 8 | 7⅞— 8 | 8 | ... |
| 60,000 | Do. do. do. 4½ % Deb. Stock Red. | Stock | ... | ... | 4 % | 116 —119 | 116 —119 | ... | ... |
| 40,000 | City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000 | 10 | ... | 5 % | 5 % | 14½— 15½ | 14½— 15½ | 15½ | 15 1/16 |
| 40,000 | Do. do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 16½— 17 | 16½— 17 | ... | ... |
| 300,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | 5 % | 134 —138 | 134 —138 | ... | ... |
| 22,475 | County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475 | 10 | ... | ... | *nil* | 8½— 9½ | 8½— 9½ | ... | ... |
| 10,000 | Do. do. do. 6% Pref., £8 pd., 40,001—50,000 | 10 | ... | ... | 6 % | 12½— 13½ | 12½— 13½ | 13⅛ | 12⅞ |
| 50,000 | †Liverpool Electric Supply, all paid | 5 | 5 % | 5½% | 6 % | 8 — 8½ | 8 — 8½ | ... | ... |
| 49,900 | *Metropolitan Electric Supply, Ltd., 101 to 50,000 | 10 | 2½% | 3 % | 4 % | 13½ — 14½ | 12 — 14 | 13½ | 13 |
| 150,000£ | Do. 4½% first mortgage debenture stock | ... | 4½% | 4½% | 4½% | 120 —123 | 120 —123 | ... | ... |
| 6,452 | Notting Hill Electric Lightg. Co., Ltd. | 10 | ... | 1 % | 2 % | 9½— 9⅝ | 9½— 9⅝ | ... | ... |
| 19,980 | St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080 | 5 | 4½% | 6½% | 7½% | 11 — 11½ | 11½— 11⅝ | 11½ | ... |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 9½— 10½ | 9½— 10½ | ... | ... |
| 67,900 | *Westminster Electric Supply Corp., Ord., 101 to 60,000 | 5 | 4 % | 5 % | 7 % | 9½— 10½ | 10 — 10½ | 10½ | 9⅞ |

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits b ng used as capital.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1893. | 1894. | 1895. | Closing Quotation, June 17th. | Closing Quotation, June 24th. | Business done during week ended June 24th, 1896. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| £0,000 | Brush Elecl. Enging. Co., Ord., 1 to 90,000... ... ... | 3 | 5 % | 2½% | ... | 1½ — 1⅝ | 1½ — 1⅝ | ... | ... |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 6 % | 3 % | ... | 1½ — 1¾ | 1½ — 1¾ | 1 9/16 | ... |
| 125,000£ | Do. do. 4½ % Perp. Deb. Stock.... ... | Stock | 4½% | 4½% | ... | 111 —114 | 111 —114 | 114 | 112½ |
| 630,000£ | City and South London Railway ... ... ... ... | Stock | 1½% | 1½% | 1 5/8 % | 42 — 44 | 42 — 44 | ... | ... |
| 28,180 | Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180 | 5 | 3 % | *nil* | ... | 2 — 2½ | 2 — 2½ | ... | ... |
| 89,261 | Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261 | 5 | 7 % | 5 % | ... | 1½ — 1⅝ | 1½ — 2 | ... | ... |
| 17,139 | Do. do. do. "A" Shares 01—017,139 | 5 | 7 % | 5 % | ... | 2½ — 3½ | 2½ — 3½ | 3½ | ... |
| 100,000 | Do. do. do. 4½% Deb. Stock Red. ... | Stock | ... | 4½% | ... | 105 —108 | 105 —108 | ... | ... |
| 110,000 | Electric Construction, Ltd., 1 to 110,000 ... ... ... | 2 | *nil* | *nil* | ... | 1 — 1¼ | 1⅛ — 1⅜ | ... | ... |
| 12,845 | Do. do. 7 % Cum. Pref., 1 to 12,845 ... | 2 | 7 % | 7 % | ... | 2½ — 3 | 2½ — 3 | ... | ... |
| 91,195 | Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000 ... ... | 2 | *nil* | *nil* | ... | 1/16 — 3/16 | 1/16 — 1/8 | ... | ... |
| 69,385 | Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ... | 2 | *nil* | *nil* | ... | 1/16 — 1/8 | 1/16 — 1/8 | ... | ... |
| 9,600£ | Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ... | 10 | *nil* | *nil* | ... | 10½ — 11½ | 10½ — 11½ | ... | ... |
| 10,000 | Henley's (W. T.) Telegraph Works, Ltd., Ord. ... ... | 10 | 5 % | 6 % | 8 % | 16½ — 17½ | 17 — 18 | 17½ | 17¼ |
| 3,000 | Do. do. do. 7% Pref. ... ... | 10 | 7 % | 7 % | 7 % | 17 — 18 | 17 — 18 | 17 15/16 | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock | Stock | ... | ... | 4½% | 109 —114 | 109 —114 | ... | ... |
| 50,000 | India-Rubber, Gutta Percha and Teleg. Works, Ltd. ... | 10 | 12½% | 10 % | 10 % | 23 — 24 | 23 — 24 | 23⅞ | 23¼ |
| 300,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 105 —107 | 105 —108 | 106 | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 1 % | 1½% | 2⅞% | 14 — 14½ | 13 15/16 — 14 1/16 | 13 31/32 | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 17⅛ — 17⅝ | 17⅛ — 17⅝ | ... | ... |
| 37,350 | Telegraph Constn. and Maintce., Ltd. ... ... ... | 12 | 20 % | 20 % | 15 % | 38 — 41 | 38 — 41 | 40 | 38½ |
| 150,000 | Do. do. do. 5 % Bonds, red. 1899 | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 54,000£ | Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ... | 10 | ... | ... | ... | 8 — 8½ | 8 — 8½ | ... | ... |

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%/5; 1891—7%§ 1890—5%

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company (£5 paid), 4—4¼.

Do. do. 7 % Preference, of £5, 8—8¼.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9¼—9⅜; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅞—8¼.

Liverpool Electric Supply, £5 (fully paid), 8—8½.

London Electric Supply Corporation, £5 Ordinary, 1—1¼.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

## THE MUNICIPAL ELECTRICAL ASSOCIATION.

(*Continued from page* 812.)

"Cost of Electricity Supply."

Mr. Henry Mayor agreed with the differential rate system, but did not think it was practicable to use Mr. Wright's method, on account of its complications and expense. His method would be to take a consumer who had, say, 1,000 lights; to give him a full supply, would take at the rate of 500 amperes per hour; if they were to put an ordinary current meter on the premises, they would find at the end of the year a certain number of ampere hours recorded; dividing that by 50C, they would have the average number of hours during which the lamps have been used, and if the charges were based on the average number of hours, they were able to differentiate the valuable consumer from the other one, and could make reductions accordingly. The larger a station became, and the further off consumers were, the more expensive they became, and instead of being a source of profit they were the reverse. He should not think it practicable to differentiate between people near the station and afar off. He considered that the lighting of the streets of small towns would give most valuable assistance in the exploiting of electrical undertakings by corporations. Mr. Sayers, of Bournemouth, had adopted the "Wright" system, which had proved satisfactory to the consumers, though they had much difficulty in explaining it to consumers. It was no use introducing a system based on the number of lamps connected. They had not found that lamps remained stationary, and customers did not give information of alterations, nor did they say when they made alterations of C.P. It would be possible for an unscrupulous consumer to deceive the central station people. A system based on the number of lamps discouraged wiring, and it was very important for central station men to show that it pays consumers to wire their premises throughout; of course, in that case the number of lamps was increased, but the maximum demand was not increased. Mr. Wright's system was, perhaps, a little unjust for those consumers who used their lights late. That could not be avoided unless they went in for differential meters, as used at Norwich and Continental places. The Lighting Acts did not allow them to discriminate between customers in different parts.

Mr. Alexander Siemens, speaking from a consumer's point of view, fully endorsed the objections urged against charging for lights installed. He gave his experience of the cost of electric lighting, which he had found at 8d. per unit to be equivalent to gas.

Mr. Arthur Ellis, of Bolton, said that at Southport, after adopting the demand system, nearly 30 per cent. of the consumers were getting light at a lower cost than previously. They had found the best customers to be the small ones. The result had been so satisfactory, that they had reduced the maximum demand to one hour per day.

Mr. Wordingham, of Manchester, continued the discussion, and spoke of the system in use at Manchester. There would be a difficulty in introducing the demand indicator into Manchester, because the Corporation would not carry their accounts over one quarter. He thought Mr. Mavor's system an exceedingly bad one. He did not agree with Mr. Wright in charging all wages to standing charges; many of the charges were running, and not standing.

Mr. Dawbarn and Mr. Geipel continued the discussion. Mr. Geipel spoke of the importance of keeping down the first capital cost. The cost per kilowatt at Brighton was £125, while at Leicester and Bradford it was £50.

Mr. Faraday Proctor spoke of a day load meter which had been adopted at Brighton.

Mr. Robt. Hammond regretted that they had been led away to discuss the Brighton system of charging; he thought that the principles laid down by Mr. Wright were very important, and showed that electricity was essentially the poor man's light. Mr. Wright briefly replied on the discussion.

Mr. A. B. Mountain, Huddersfield, read a paper, left over from Wednesday, on "Electricity Works' Records," of which the following is an abstract:

"The subject is one of such importance, that the author felt great reluctance in undertaking the writing of a paper upon the subject; and it must be understood that no attempt has been made to do more than give an idea of the chief records required.

"As the Board of Trade have arranged a form upon which accounts must be rendered each year, it is as well to arrange the details to suit. An account of the capital expenditure should be kept in such detail that the cost of any extension may be at hand for future reference; and if an order number or account heading is arranged, and the cost of materials and time posted to this account heading, at the year end it is an easy matter to bring together the several small accounts into the form required by the Board of Trade.

"The Time Sheet given shows the time of any man, upon what work he was employed, and the cost of such time.

"The Stores Order Form shows the articles taken from stores, and for what such articles were required, and the cost of same. The expenditure upon mains and services, if kept in this detail, will be of the greatest assistance when estimates of extensions are required.

"The revenue account requires keeping in such a manner that the several details of expenditure may be compared with the previous week. The Cost Sheet given shows the several items to be recorded, the sheets being arranged for one month's expenditure. The metered units were recorded upon this sheet at the end of each month, and the comparison shows the approximate position of the works.

"The Engine Room Cost Sheet gives the cost of coal, water, oil,

and stores used during the week, as well as showing the results obtained during any portion of the year.

"The Plant Testing Record shows the value of fuel, evaporation of boilers, steam used per I.H.P., and efficiency of generator.

"The Daily Log Book gives all particulars as to the running of generating plant and load upon the station.

"*Record of Mains.*—This is one of the most important records, and also the most difficult to arrange. The easiest method is to work from the junction boxes fixed, or from corners of a street, and keep each section of mains separately.

"*Main Testing Record.*—This is arranged to give the condition of the insulation of the whole system of mains, both feeders and distributors.

"*Consumers' Register.*—This covers all matters connected with each consumer, commencing with the service lines and sizes of fuses controlling the premises, and gives particulars of the installation, when connected, tested, and by what firm the inside work was done.

"It is extremely difficult to approximate the load which the generating station will require to bear during the next year, owing to the fluctuating rate at which consumers are connected; but if the lamps are added weekly, it is easy to ascertain approximately what the highest load upon the station is by dividing the watts installed by the highest proportion of lamps burning to lamps installed obtained during the preceding season. Where distributing mains are supplied from sub-stations, it is important to form an idea of the load to be placed upon the sub-station, but for obtaining the highest load upon any distributing main it is necessary to fix a recording ammeter."

Mr. Jos. A. Jeckell, borough electrical engineer, South Shields, read a paper on "Cable Specifications and Tests," of which we give an abstract:—

"It is not too much to assume that all borough electrical engineers are capable of deciding what, in their opinion at any rate, is the most suitable kind of cable for their purpose; and having done so, it is only right that they should clearly set forth in the specification what cable is required.

"It is not at all fair to contractors for an engineer to issue an open specification, when he has a very clear idea what cable he intends to have, and it is only a question who will offer it on the best terms. The specification cannot be as favourable to one maker as to another, if he does not define clearly what he wants; but if he does this, there is an end of the matter. If the specification states that compound cables are required, then all makers of compound cables are very much on the same footing, and makers of rubber cables are out of the hunt, and *vice versâ*.

"Another reason for clearly stating what manner of cable is required, is that there will be much less difficulty in stating what tests the cable will be required to stand, for those which are suitable for a rubber cable are unsuitable for a compound cable, and *vice versâ*, perhaps. If an engineer, for instance, is determined to have rubber-covered cables, how much better it would be if he said so clearly, and not exclude all others by putting in some test which he knew none but rubber-covered cables could stand.

"Let it be assumed, therefore, that the engineer has made up his mind what kind of cable he wants, and that he clearly sets this forth in his specification.

"Tinned copper wire for cable manufacture can now be obtained, having 100 per cent. conductivity, according to Dr. Matthiesen's standard.

"If the price lists of the various makers are examined, it will be found that there is a very considerable difference between the conductive resistance of cables. This may be accounted for by many causes; for instance, the conductivity of the copper used, the length of lay of the wires, the tightness of the lay, whether the wires are twisted or cabled, and whether each wire in the strand is more or less insulated from the rest.

"A very simple way to get over all these difficulties, and to obtain just what is wanted, is not to give the number of strands and their size in the specification, but simply specify what resistance per mile the conductor has to be, and the number of strands of which it has to be composed, and, if desired, the conductivity of the copper.

"All strands should be cabled, and not twisted, *i.e.*, the machine used for this purpose should be of the sun and planet motion; unless this is done, the wires will themselves be twisted, and therefore hardened; but very few makers are so far behind the times as to use the old twisting machine now.

"If the cable required is concentric, care should be taken to specify that the outer conductor must have the same copper resistance as the inner; for if the outer has the same sectional area as the inner, its resistance certainly will be more than that of the inner. It has been known to be as much as 7½ per cent. more; but this is rather an outside figure.

"Now as to the insulation; the specification of this, of course, depends upon whether the engineer has decided to have rubber cables or compound. If the former, it is well to specify that the rubber shall be well vulcanised together, so that the different layers cannot be parted by mechanical means, because there are cables where the various layers can be peeled off from one another. And it is as well to state that the tape or felt next the rubber which is vulcanised should be broad, because a narrow one sometimes presses too deeply into the rubber when it is vulcanised, if it has been put on rather tight. With regard to the insulation resistance, this must, of course, depend upon the kind of cable required.

"There is no use in having a very high insulation resistance *per se*; what is required is an insulation that will not deteriorate. If, however, rubber cables are specified for, it is absolutely necessary to fix a high insulation resistance per mile, because when a sufficient thickness of rubber has been put on for mechanical purposes, the insulation resistance is sure to be high, if the rubber and workmanship are good.

"It is hard to obtain a very high insulation resistance on a rubber-covered cable unless the rubber and workmanship are of the best, and therefore, generally speaking, for a given thickness of rubber insulation, the insulation resistance is a very fair test of the quality of the material and workmanship. If a high insulation resistance is obtained, even when poor rubber is used—and it is possible to do so—the rubber will generally, on examination, appear to be of inferior quality.

"About 5,000 megohms per mile is a very fair insulation to require for a first-class rubber cable, and, of course, this test should be made with a battery having at least 500 volts. But if compound cables are specified for, it is very undesirable to insist on a high insulation resistance; not that it is impossible of attainment, but if it is obtained, it is pretty certain the cable will be quite spoilt.

"Great care should be taken in accepting a compound cable having a high insulation resistance; for this reason a pressure test is of much more value, in order to see if a compound cable is good or not.

"The weak point of a compound cable is that it is liable to be damaged if it is bent, therefore it is as well to put into the specification a bending test.

"It is very much safer and more satisfactory that the makers of the cables should do the laying, because otherwise they could not guarantee them, as even the best cable can be irretrievably damaged by being badly laid, and it is really surprising how very few men know how to lay a cable properly. The writer is not, however, an advocate of letting the trench work to the cable manufacturer. This work they would sublet generally, and it is much more convenient that it should be done by the Corporation workmen who are always engaged in repairing the streets, &c.

"Whatever tests are specified as having to be conducted at the makers' works should undoubtedly be repeated, as far as practicable, after the cables have been laid and jointed up.

"For a rubber cable for high tension working, a pressure test of double the working pressure, and afterwards a test of the insulation in megohms, which should be about 5,000 per mile, would be satisfactory. The copper resistance should also be taken, to make certain all the joints are well made.

"It is rather hard to specify what the insulation resistance of compound cable should be, because the resistance varies very much with the different substances used for insulation; but, of course, the insulation should be uniform.

"The insulation tests will be made after one minute's electrification, because that is the generally accepted method; but why one minute should be the time limit is not very evident. It would be all very well to have one minute as the time limit, if all substances electrified equally; but it is quite conceivable that we might have one cable which, after one minute's electrification, showed a lower resistance than another, and yet when it was completely electrified, it might show a higher insulation resistance than the other. Therefore there is an additional reason for specifying a pressure test.

"This pressure test would probably vary under different circumstances, some makers not objecting to test their cables to 20 times the working pressure.

"The question of a long guarantee is rather an awkward one, as many makers will not guarantee their cable unless their own men make all the joints on it after it has been put to work."

A discussion followed Mr. Jeckell's paper, of which the following are the principal points.

Mr. C. H. Wordingham said, although they wanted a thoroughly good system of mains, they also wanted a cheap one, and they could not say that any one was particularly the best. What they did want was a perfectly definite specification. He was inclined towards an alternative specification, one for rubber, and one for any other class of cable. He quite agreed that high insulation was not necessary. Rubber insulation might be low and still be good; they wanted, however, some mechanical tests; for instance, a bending test for lead was very desirable. He disagreed with the author in allowing one man to put in pipes and another cables, because so much more depended on pipes than drawing in the cables. He thought the breaking down test ought to be tried on a short length, for it was unwise to strain a cable that one was going to use.

Mr. Mountain, of Huddersfield, had had some difficulties with cables, his experience of the combined arrangement had been a sorrowful one. In drawing cables into pipes they got mechanical damage to the cable, especially with rubber cables. He thought the best system was to place the mains direct in the ground.

Mr. McLean asked why there should be any chance of damaged cables if the pipes were properly laid, and if damage were caused it ought to be found out at once.

Mr. Alexander Siemens said the author spoke of rubber and impregnated jute cables, as if there were no others. Rubber cables, unless they were covered with lead, were no good whatever, especially in places where they were alternately wet and dry. Ordinary rubber deteriorated much quicker than vulcanised rubber. The insulation of a cable should be uniform throughout, and if there were 100 miles, the last mile should be like the first. Mr. Siemens then gave his experience of the test of a jute cable. Generally speaking, Mr. Siemens condemned rubber and advertised his own wares.

Mr. Stuart Russell spoke of high insulation not being necessary. High insulation was not a proof of the good quality of a cable, nor low insulation a proof of its badness. With regard to stranding, he could not understand the figures given by Mr. Jeckell of 7½ per cent., unless the outer was laid up with a very short lay. The resistance of the inner and outer conductor should not be different. It was to the manufacturer's interest to use high conductivity copper; there was less weight and less insulating material.

Mr. Nisbett said the question of the durability could not be tested in the factory. He thought that Mr. Siemens had put a nail in the coffin of unprotected rubber cables. Mr. T. O. Callender made many suggestions in the way of improving engineers' specifications. Mr. Crompton thought the main cause of failure in rubber cables was a

chemical one, and if vulcanising was not properly carried out, chemical changes took place. Mr. Raworth continued the discussion, and it was announced that Mr. Jeckell would write out his reply, and send them to be printed in the *Proceedings*.

Mr. E. T. Ruthven Murray, city electrical engineer, Worcester, read a paper "On the Organisation of an Electricity Works Staff," of which we give the main features:—

"As the success of an electricity works depends in no small degree upon the staff directly engaged in running the plant, the organisation of this staff requires considerable judgment on the part of those responsible for their engagement.

"No hard and fast rules can be laid down as to the number of men necessary on the staff, as this will depend upon the individual characteristics of the electricity works. Among other matters to be considered, which have a direct bearing upon this, are the size of the works, their designs, the system employed, whether a direct-current battery station or an alternating current supply, and, of course, whether the supply is constant or intermittent. Unless there be a large demand throughout the night for public lighting, or an intermittent demand both by day and by night, for motors, the small battery station may be able to give a constant supply with only one watch of men, whereas the alternating current station will require three eight-hour watches. How many men are required for a watch will depend upon the size of the works; but probably it will be necessary to have at least one engineer in charge, one driver, and one fireman. The number of men necessary will be lessened by careful design of the works; the number and sizes of engines and their arrangement, the use of mechanical stokers, coal conveyers, and the situation of the coal bunkers. All these details will influence the economical and easy working in addition to the size of the staff necessary.

"A variety of opinions exists among different engineers as to the precise duties one man can perform, and also what men are necessary —some considering electricians or engineers in charge and switchboard attendants superfluous, while others hold the same opinion with regard to greasers, cleaners, and coal trimmers. It is certain that by a proper understanding at the time of engagement, especially if one does not take them from over-manned stations, men can be obtained who will combine the duties in a perfectly satisfactory manner for which in other works two men will be employed. It behoves the engineer to be particularly careful and far-seeing in engaging a staff to keep the wages item of the standing charges as low as is consistent with safety; since when the output is small this item is a heavy burden on the young station. If a good fitter-driver is engaged and kept on light load watches it will be possible to dispense with a regular fitter until the works can afford to keep one, and it should not be necessary in the early existence of the works to employ both cleaners and greasers—indeed, in some stations these men do not exist. Either locomotive or marine engine drivers and firemen are found particularly well suited for service in electricity works, as their previous employment seems to give them steady nerves, and this will prove invaluable in emergency. They have also more economical ideas of working.

"Regarding assistant engineers, it seems only right and proper to employ them, as one can hardly expect either the engine-drivers or switchboard attendants to have the necessary technical training to enable them to take entire charge of the works during the absence of the chief engineer; moreover, it is obviously necessary to give some one man the general responsibility of the proper working of the station during each watch. Undoubtedly the best men for the post are those who, in addition to having received a thorough technical training, have served an apprenticeship in a good mechanical workshop. It is admitted that the mechanically trained man proves more useful and reliable than the purely theoretical electrician.

"In works having a large area of supply, a distribution engineer will be required to superintend the outside work, such as the laying of mains, the testing and connecting of consumers' installations, and to take the more direct charge of the outside staff of meter-readers, jointers, wiremen, and the labourers necessary for opening up the streets. It is almost essential, at any rate advantageous, that the distribution engineer should have had some station experience. The number of outside men required will vary at different periods of the year, and in many municipal electricity departments arrangements can be made with the surveyor to lend labourers whose bare time is charged against the department. Notwithstanding that the greater part of the outside expenses go to the capital account, such an arrangement is of great assistance in reducing wages under this head.

"In organising the staff, it is most important that the engineer be allowed to choose or recommend men for appointment, and that the men know to whom they are responsible. It is the greatest mistake for the committee who have charge of the department not to allow their chief engineer a free hand in this respect, and internal troubles in electricity works have often been due to this cause."

A paper by Messrs. John Hesketh and John H. Rider was read at Islington on "Combined Electric Lighting and Traction Plants," of which the following is a full abstract:—

"The tendency during recent years to municipal control of local transit offers an excellent opportunity of pointing another object lesson, and adding a further example to the many already adduced, of the way in which electrical supply may be cheapened by judicious foresight and careful application of our present knowledge.

"Many Corporations at the present time own, but do not work, their tramways, and in the near future it may be safely prophesied that those Corporations who willingly lease their lines will be in a minority. In almost every instance, at present, the lessee provides the motive power, generally horses, to deal with the traffic on lines constructed by the lessors. Therefore, when the time for a revision comes, and Corporations begin to work their lines themselves, they will probably be left to provide a complete equipment of new rolling stock and motive power.

"That electricity will be considered is certain; that it will be adopted in many instances is equally certain. But there still remains one very important question to decide in connection with the generating plant, and that is, Shall the plant be separate and distinct, or shall it be combined with a plant for electric lighting?

"In many cases the plant for electric lighting will already exist, most probably on a system unsuited for direct application to tramway purposes; and the tendency may be to say that as the purposes are distinct, then keep the plants separate and distinct. To show that this tendency is wrong is the object of this paper.

"Whether two separate systems be used in the one building, or whether both plants be identical, the combination has already been carried out to a practical issue in America, Europe, and elsewhere. That it has not been hitherto done in England is due rather to force of circumstances than a lack of appreciation of the practicability and importance of the combination.

"In cases where low tension direct curent systems are in use for lighting, the question is very simple. If the voltage employed for lighting be unsuited for tramway purposes, a motor transformer can efficiently be used. This also holds good for an alternating high tension system—in fact, be the voltage or current of the lighting plant what it may, motor transformers can be arranged to supply a suitable current for the tramways, generally continuous at 500 volts.

"There can be no doubt in anyone's mind as to the possibility of the combination, and it would result in cheapened supply for both purposes. Such a combined plant, worked economically, ought to produce current for all purposes at from 1½d. to 3d. per unit, according to the demand. This is simply due to the combined load factor being a very good one. Were the load factor of a lighting station equally good, the cost of production would be equally low. This is demonstrated in more than one instance in practice. Indeed, it seems almost useless repeating the arguments in favour of it, so sure are they, and so strong has the evidence up to the present been in favour of such a scheme. To quote from a recent publication:—

"'This has been realised on the Continent, where in several large towns the tramway companies are buying current from municipal electric light works. The lowest price paid is at Geneva, where the tramway company guarantees a minimum consumption of 500,000 units per annum, and pays 1·15d. per Board of Trade unit.

"'Hamburg is another example of a tramway company buying current from the lighting station. In this case the tramway company guarantees a minimum annual consumption of 2,500,000 units. The lighting company has to pay a fine of 9·6d. for every car mile which the tramway company may not be able to run owing to any failure of the power plant. The total expenses of the tramway company, including depreciation, maintenance, interest on bonds, sinking fund, &c., are only 3·95d. per car mile.'

"At Havre, too, the tramway company buys current from the lighting company, and at 1·75d. per unit.

"The question as to the system on which the combinations should be made is a most important one, which we will now briefly consider.

"We may have (*a*) a separate and distinct tramway plant within the same station buildings as our lighting plant, and under the same management and control; or (*b*) we may utilise the existing lighting machinery by various methods.

"If we adopt the former, we shall require separate engines and generators, and also additional boilers, which, however, may be worked in conjunction with the existing boilers and steam pipes. In other words, we shall require nearly as much extra plant as though the tramways were being worked from a distinct station. The only advantages will be that the existing buildings (enlarged) and the existing lighting staff and management will be available.

"It is clear that this must be so, when we remember that the tramway load will not conveniently shut down as darkness comes on, and that for a few hours each day, chiefly during the winter months, the whole of the lighting plant will be required for lighting purposes, and during this time the tramcars will have to be driven as well. The effect of this combination will therefore be to give an excellent day load (after 6 a.m.), but it will also increase the 'peak' by an equal amount.

"This is a great improvement on the load factor of the station, but cannot we go one better?

"If we utilise the existing machinery of the station for driving the cars, we must in the first place supply a current suitable for tramway purposes, and, in the second place, provide power for running the cars during the time of the heavy lighting load.

"As mentioned earlier, if the ordinary station supply be not suitable for direct use, we may obtain anything we want by means of rotary transformers, *i.e.*, by coupling a continuous current generator to a continuous current motor in the case of a direct current supply, and to an alternating current motor in the case of an alternating supply. The combined motor generator could be conveniently placed in a sub-station close to the tramways, and should be provided with a specially designed heavy fly-wheel, in order to minimise the effect of the starting of the cars upon the station machinery.

"The power required for driving the cars during the period of heavy lighting load may be obtained from accumulators. These should be of sufficient capacity to drive the cars for, say, five hours. The actual number of hours they would be required would vary with the time of the year; but in the depth of winter it should not be more than this, while in the summer months it would be very small indeed. These accumulators would be charged directly from the station machinery, if suitable, or from the same motor generators which supply the cars in the daytime. A sample winter's day's working would be somewhat as follows, viz.:—

"11 p.m. to 6 a.m. (seven hours). Car traffic stopped. Motor generators charging accumulators at full rate. Only small lighting load.

"6 a.m. to 5 p.m. (11 hours). Cars running. Motor generators supplying current for cars in parallel with accumulators, which would then be fully charged. Accumulators helping to furnish such sudden heavy demands as may be required, and also being partially charged when cars were only taking small current. Full steady load could thus be kept on motor generators and station machinery all day. Only small lighting load.

"5 p.m. to 10 p.m. (five hours). Cars running. Motor generators stopped or running light. Accumulators supplying entire current for cars. Heavy lighting load.

"(As explained above, the actual demand upon the accumulators would depend on the time of the year and the requirements of the lighting load.)

"10 p.m. to 11 p.m. (one hour). Cars running, but gradually ceasing. Lighting load going off. Motor generators helping to drive cars, and gradually increasing until full power could be put on for charging the accumulators.

"The use of accumulators in the manner described would have the great incidental advantage of rendering the car service independent of a temporary breakdown of the plant, either in the case of a motor generator or any part of the generating machinery. The fields of both motor and generator could be excited by current from the accumulators, and the latter could also be used in alternating current systems to run the plant up to synchronous speed before switching on to the high tension alternating mains. The accumulators would also help (in conjunction with the heavy fly-wheel on the motor generator) to lessen the effect of the starting of the cars upon the station machinery, so that the station load would only vary slowly, and that to a small extent, with a fair number of cars running.

"It may be asked, 'Where is the accumulator which will do all this?' We all know that accumulators have been tried for traction purposes with disastrous results, but in such cases they have been carried *on the cars*, and have had to do the entire daily load. In the scheme suggested the accumulators are stationary, are subject to no jolting or other mechanical strains, and are under skilled supervision at all times. Instead of being called upon to drive the cars the whole day through, they would only, at the outside, have to do about 25 per cent. of the total work, and that only for a few months in the year. On the average, about 15 per cent. would be their share. The sudden rushes of current on starting the cars would be partly met by the heavy fly-wheels on the motor generators, so that the life of the accumulators should be fairly good.

"So far as prime cost is concerned, there is very little to choose between this arrangement and the former. The motor generators would cost about as much as their corresponding power in direct-acting steam plant, while the accumulators could be purchased for the money otherwise expended in spare steam plant, boilers, pumps, pipes, boiler seatings, and extended station buildings. But in the annual running expenses there would be some economy, particularly with respect to the boilers. If a distinct plant were used for the trams, steam would have to be kept up all day in sufficient boilers for the full tramway and lighting loads, as all the power would be required when darkness came on. This would mean both a larger chimney and also more stokers, while the fuel and water consumption would be increased.

"The motor generators being simply rotary machines, there would not be the same wear and tear as on the separate steam engine plant, while a 10 per cent. to 15 per cent. charge should maintain the accumulators, particularly as makers will now enter into maintenance rates for lighting cells at only 4 per cent. per annum.

"The question of a good day load, and consequently cheapened production, is of such vital importance to our industry, that it will repay every attention which can be given to it. That a combined station is the right thing there can be no doubt. As to which system the combination should be carried out upon, there may be differences of opinion, and it is to bring out those differences of opinion that this paper is laid before you."

On Friday, Mr. A. H. Gibbings, borough electrical engineer, Bradford, read a paper on "Extensions to Outlying Districts," of which the following is an abstract:—

"The extension of electricity supply from the central station to the outlying districts of a township has already become in very many cases a matter of urgency, and while there always exist distinctive features in each case, there are also many points common to all which may be considered with advantage.

"The municipal electrical engineer is face to face with the problem of extending the supply in the most economical and satisfactory way; the town councillor has before him the demand for the supply from the members of his constituency in outlying districts.

"There are at present in operation in England, Scotland, Ireland, and Wales about 51 municipal electric light stations; and those towns which have already obtained their provisional order, and have electricity works in course of construction, number about 20, making a total of 71 municipal electric light enterprises in the United Kingdom. Of the above number, 19 have been in operation over three years, and it is generally after the lapse of this period that the *necessity* to extend the hitherto confined area begins to be felt. The writer is inclined to curtail the time by 12 months, for reasons which will be put forward towards the end of this paper.

"Having decided that the necessity for extension will surely arise, *nolens volens*, the points to be considered may be stated to be:—

"1. The cost of extending the supply.
"2. The effect on the cost of production and revenue.
"3. The advisability of extensions.

### 1.—The Cost of Extending the Supply.

"The cost of extending the supply is affected by:—
"1. The method of laying cables.
"2. The characteristics of the suburban or outlying district.
"3. The extent and class of demand.

"By the method of laying is meant the system which in economy and efficiency is found to be most satisfactory when the character of the suburban district, and the extent and class of the demand, are taken into account. It is, therefore, essentially a question to be decided for each district separately, by each town individually, considered with reference to the general system of electrical supply adopted by each. But after all this has been said and emphasised, it is also universally true that many of those items which form so large a part of the cost of laying mains in the centre of a town are very much modified, if not entirely eliminated, in connection with the extension of mains in the suburbs. Such items are:—(1) The reinstatement of footways and road paving; (2) the necessity for making ample provision for future demands by laying additional conduits; (3) the avoidance of obstacles under the footways and roads.

"It is not necessary to enlarge upon the very different effect which these items have upon the cost of laying the mains in the central and outer districts respectively. Attention is drawn to them, merely because in some towns the difference will no doubt be very much greater than in others.

"A proportion of the cost of reinstatement of conduits and cables laid really represents capital already spent for an extended supply, capital lying idle until a revenue is derived from outside.

"The method of laying cables in the central area is very naturally determined by the conditions referred to above, but where such conditions do not exist, as in the outer districts, other methods of laying mains may be adopted, by which the cost may be still further reduced when compared with that involved by the original method. For instance, in the case of a low tension supply, the first necessity of heavy feeders and distributing mains laid in expensive conduits might be substituted in the outer areas by armoured cables laid directly in the ground; or in the case of high tension, by a system of banked transformers substituted by direct supply to each consumer.

"The characteristics of the outlying districts and the probable extent and class of demand, considered in relation to the cost of extending the mains, may now be considered. Let us take these two items together, as the one depends very largely upon the other. In the very broadest sense these, of course, are really the determining factors with regard to the size and length of mains to be laid down. It can be shown that this may be ascertained as a very much more definite quantity than is possible when estimating the probable demand in the central area. The outlying districts may be scattered and thinly populated, or they may be the reverse. There are usually both instances in most towns. Scattered districts are likely to be composed of large houses, rich residential neighbourhoods, and unpaved streets; in the second case, main streets leave the town, with a continuous run on each side of terrace houses, occasional shops, with a surrounding neighbourhood of side streets and residences.

"Now the very first advantage we have in considering the possibilities of supply in the above cases (and the consequent size of cables ultimately required) is the knowledge that, while the probable demand from business quarters is a greatly varying quantity, utterly impossible to forecast, in residential districts it may be comparatively easily gauged. Some shops in the centre of a town are let and re-let in the course of two or three years; one tenant requiring eight or ten lights, another requiring no light at all, and a third demanding a supply of 40 or 50. This is only a typical instance of what occurs over and over again in the course of 12 months. Under such circumstances there is no basis upon which to work, and hence we have to be prepared for any demand. But it is different with residential houses. The annual rental is a safe guide.

"Therefore, it should not be a difficult matter to estimate the maximum number of electric lamps likely to be required for many years in such a district. Hence we can see how the characteristics and probable demand enable us to make accurate calculations, and so economise in the method of laying and the capacity of the mains.

"Now, it will readily be admitted that the points just dealt with are the very points which form the basis of comparison in estimating the relative value of one system over another. But, whatever the system, there can be no doubt that the cost of extending the mains can be very considerably reduced when compared with the cost of laying mains in the centre of the town.

### "2.—The Effects on the Cost of Production and on the Revenue.

"Supplying outlying districts with electricity appears at first sight simply to entail increasing the output at the central station, with a corresponding increase in the revenue. And the cost of production appears to be affected just in the same way as if the additional supply occurred in the central portion of the town. In reality, however, the effect on the cost and revenue is of a much more important nature, and it is this feature which gives the supply a relatively higher value. This is due entirely to the fact that the number of units consumed for a given maximum demand is very much greater in the outlying districts than for a corresponding demand in the centre of the town. In other words, private houses, small shops, &c., use the light for a greater number of hours than business offices and large shops within the central area. While the latter use a large number of lamps for a few hours a day, the former use only a few lamps, but burn them a considerable time. And so it comes about that the number of lamps installed cannot be made a direct and all sufficient basis of calculation in estimating the probable revenue. We must also take into consideration the number of hours the lamps burn. Considerable assistance may be obtained in arriving at an approximately correct estimate if we know what is the general figure in lamp-hours per day in several towns.

"The average of eight towns is 1 hour 33 minutes; or, in other words, the total capacity of the station is being used for only 1 hour 33 minutes per day in producing the satisfactory results to which these towns have attained. There can be no question that the time during

which the major portion of the revenue is earned is for the first two or three hours after dusk. A reference to any central station load curve will prove this; and, further, that more than 50 per cent. of the lamps connected are not in use at all for six months of the year. Now, this is just where the private consumer comes in and fills the gap. His lamps, although adding to the plant capacity at the station, also increase the average earning capacity, and in the proportion estimated in the following instance:—

"If we assume that an equal supply is demanded by the central and the outer districts respectively, then, of course, the plant capacity at the station would be double that required for the central portion only; and if both classes of the demand were like that in the central area, the whole plant would still be earning its entire revenue in 1½ hour per day. But it may be safely assumed that 75 per cent. of the demand in the outlying districts will be continued from 7 to 11 pm. on an average throughout the year, or, say, for fully four hours longer than the central portion. Now, 75 per cent. of half the maximum demand is equivalent to a little above one-third of the maximum demand continued fully for four hours, and this is, of course, equal to the full demand continuing for one hour and three-quarters. It will at once be seen from this simplification of the matter that the earning capacity of the plant has been increased from 1 hour 33 minutes to 3 hours 18 minutes, or more than two-fold: or, in other words, the number of units sold are doubled for the same maximum demand. But what is true of the whole is true of a part, and hence the earning value of every 8-C.P. lamp connected in the outlying districts is three times as great as that of a corresponding burner in the central portion of the town. In addition to this relatively higher value of the residential supply as compared with the shop and office supply, the former would be required very largely on Sundays, thus giving an additional 52 days' consumption on the year. It would also form a better load on holidays, and during the winter months from 6 a.m. to 8 a.m. For all these reasons such a supply is eminently desirable.

"Having determined the relative value of the demand from the residential districts, it is an easy step to ascertain the effect on the cost of production and on the revenue. Taking the average of a score of central stations, the charge per unit is about as follows:—

| | |
|---|---|
| Generating cost ... ... ... ... | 1d. |
| Standing charges ... ... ... ... | 3·5d. |
| Total ... ... | 4·5d. |

"With a slightly increased efficiency of the generating plant, that portion of the cost is likely to be slightly reduced; but it may be taken nevertheless to remain practically the same per unit, namely, 1d. But, assuming an equal demand in both central and outlying districts, the number of units sold for the same standing charges is doubled, and therefore this item of the cost would decrease in the same ratio; that is to say, the 3·5d. per unit would become 1·75d., and the total cost per unit 2·75d. instead of 4·5d. This at once opens up the possibility of a substantial reduction in the price: a reduced price would probably attract new customers, and thus, step by step, we might ultimately arrive at a universal adoption of the light. We can even imagine the demand from the outlying districts being twice as much as that in the central area (a very common feature of gas supply), and in that case a general price of 3d. per unit would then be most remunerative. This at least seems to be certain, that every lamp connected in the residential districts has the effect of helping to reduce the standing charges in the ratio of 2 to 1, as far as its own consumption is concerned.

"With the foregoing explanation it is easy to see what is the effect on the revenue. The price to the consumer remaining the same, 5d., 6d., or 7d., the revenue or *net profit* would be increased by exactly the same amount as the standing charges would be decreased. In the example given, the standing charges would be decreased by 1·75d. per unit, and by itself this amount would form a very considerable net profit, even if the average charge per unit was only 4½d. The average price obtained, however, by most municipalities is more than 4½d., and at that price a net profit is made of from 3 to 5 per cent. Of course, the object of the municipalisation of these undertakings is to supply electricity at as low a price per unit as is consistent with fairly paying expenses and providing for contingencies; but the price will never descend to a popular figure while the supply is confined to the central area. The possibility of a reduction commences, however, as soon as the many-hours private householder has the opportunity of using the light. Such a reduction should take place naturally and gradually, as the demand in the other districts increases; and when we remember that every lamp supplied there brings in the same revenue as three in the central portion, the effect on the profits of the department would not be long in becoming apparent.

"3.—The Advisability of Extensions.

"The writer has endeavoured to show that as a question of finance extensions would probably be very remunerative; but there is, of course, still another factor to be taken into consideration, and that is the rate at which consumers will avail themselves of the new light in these districts.

"The success which has been met with, however, has been beyond expectation, and this fact is in clear evidence by the present 51 Corporation electricity supply undertakings, and by the efforts of several other municipalities to buy up the rights which they have so recently allowed to fall into the hands of private companies. These rights and undertakings will undoubtedly have to be paid for very heavily before the Corporations become possessed of them.

"We might reasonably infer, I think, from what has been the experience in regard to the central area, viz., that while it was difficult to forecast the probable demand, yet the result has been a very general adoption of the electric light, so with regard to the outlying districts, the result should be an equally steadily increasing demand.

"Of course, the streets with which to commence the extension have to be selected with discretion, but, once started, a supply will soon be demanded over the entire area of the borough.

"I mentioned in the first part of this paper that I considered two years a sufficient period after the establishment of the electricity works to initiate a scheme for the supply to the outlying districts. My reasons for naming two years are two-fold. First, at the end of that period the supply will probably have become generally known and appreciated, and the financial position of the undertaking is generally sound and good. Secondly, I think it very desirable that the inner and outer districts should then grow simultaneously. The load curve would thus be improved, and the probable future needs of the town would be more readily gauged and satisfactorily provided for than would be the case if the extension were long delayed.

"To sum up the whole matter: To me it appears that at the present time the great object for municipalities to aim at is the reduction of the price at which electricity can be supplied. I contend, and have endeavoured in this paper to justify my contention, that this object is attainable. Not only so, but that it may be attained in a most satisfactory manner by developing the enterprise. Like the railway companies of old, I have every confidence that we should go *forward*—certainly not in a headlong spirit of reckless extension, but, on the other hand, with an unhesitating and deliberate movement of advance."

## SINGLE-PHASE ALTERNATE CURRENT TRANSFORMER IN PRACTICE.*

By A. F. BERRY.

(*Continued from page* 814.)

When currents are circulating in the coils, repulsion between them takes place, and the greater the current strength the greater the repulsion, but the greater the distance between the coils the smaller the secondary induced E.M.F. becomes owing to magnetic leakage; we have therefore, to adjust the transformer experimentally to give a certain current, and we at once have a constant current transformer. I believe a dash pot is used to prevent "hunting," and other mechanical details are carefully attended to so as to render the movement uniform and reliable.

The difficulties arising in connection with designing a good constant current transformer, which has no movable parts, have not yet been altogether overcome, and are chiefly these: the variation of the permeability of the iron employed, difficulty of estimating exact dimensions of iron circuit and coils, with inability to readjust transformer to give varying constant currents; by this rather paradoxical statement I mean—to give either A amperes constant, or to give A′ amperes constant.

Transformers for use with welding apparatus are, of course, a special type as a secondary voltage of only about four volts is required, in connection with a current whose value is estimated by thousands of amperes; the chief features to be considered in welding transformers are:—

(1) Periodicity employed.
(2) Position of secondary conductors.

The periodicity will decide whether we must use a conductor for the secondary having a very large surface or not, and to avoid loss due to Foucault currents being generated in them; if the periodicity is high we shall have to use a conductor with a large surface to reduce what is known as skin resistance, due to the fact that it takes an appreciable time for a current to grow into a conductor whose inner parts are far removed from the surface.

The position of the secondary conductor must be such as to ensure all primary flux cutting through them, and should be such that after leaving the transformer they will not produce unnecessary drop of volts on the way to the welding apparatus, by virtue of their self-induction.

The best periodicity to use with welding apparatus seems to me to be about 75 ~ per second, for we then have cost of construction moderate as well as comparative freedom from "skin effect" trouble.

Transformers to be used to transform very high pressure currents (5,000 v.—20,000 v.), are rendered less efficient and more costly than those of similar output but lower voltages, on account of the number of turns and requisite insulation, and greater labour and care in constructing, the coils have to be large so as to be well insulated and consequently the iron and copper circuits lengthened.

Modifications might with advantage be often made to suit such details of the supply system, as, system of mains to be run with and type of alternator supplying current.

Material Used in Construction.

In dealing with material we have to consider the iron forming the core, or magnetic circuit: this we may use in the form of stampings, wire, or strip; stampings are used principally, wire and strip being the exception, some makers use a very mild steel, others charcoal iron; I usually prefer iron, although latterly, steel, showing exceedingly low hysteresis loss, has been made and is largely used by various makers.

Hysteresis loss of iron depends on
(*a*) Quality employed.
(*b*) Time it has been used in a transformer.

* Paper read before meeting of student members of Institution of Electrical Engineers, May, 8th, 1896.

(*c*) The number of times the magnetism goes through its values per second, and

(*d*)* The manner in which it goes through those values.

(*e*) Maximum value of B (*i.e.*, the number of lines per square centimetre being forced through it), the watts = $a\,B^{1.6}\frac{}{}$.

(*f*) Weight of iron under influence of magnetic forces.

All the above facts, excepting (*b*) and (*e*) will be obvious at once if one draws a hysteresis curve and thinks upon it for two minutes.

Iron is now sometimes, and therefore ought always to be, obtained absorbing as little (when first delivered) as ·20 of a watt per lb. at 100 ~ per second and a value for B of 2,500.

The eddy current losses in iron vary directly as periodicity $^2$, $B^2$, and thickness of stampings; these are easily seen to be in accordance with our conception of varying strengths of magnetism and energy expended in circuits carrying current.

Variation of the quality of iron procurable is the one great element of chance in calculating transformer losses, and iron manufacturers are beginning to realise the necessity for striving after a method of production which will give iron of uniform quality, and, thanks to the Ewing magnetic tester, they can now determine in a very short time and without delicate experimenting, the losses due to hysteresis in a sample of iron, and will in the future probably make themselves better acquainted with the magnetic properties of their productions than they have in the past.

The conductivity of the copper employed for transformer coils ought, of course, to be as high as possible, and the wire well and uniformly covered, the shape of the conductors being such as to offer resistance to Foucault currents, to economise space, and allow of easy manipulation.

Insulations used ought to be mechanically strong, durable, conductors of heat, exempt from free acids, easy to manipulate, and cheap.

Those insulations possessing the majority and most important of the above features should alone be used, but it is difficult to say which is best in all cases, common sense and experience being the best guide in this as in all other engineering practice.

### Efficiency.

There are two distinct kinds of efficiency.

(1). Calculated.

(2). Measured.

The latter is often taken roughly by makers, but the former is preferably given to intending customers; it is measured efficiencies which ought only to be taken any notice of, unless calculated ones are identically the same and guaranteed absolutely.

Calculated efficiency is arrived at for any particular load, in this manner:

Consider

$C_p$ = primary current in amperes

$$= \text{secondary current} \times \frac{\text{secondary turns}}{\text{primary turns}}$$

$$= C_s \times \frac{\text{secondary turns}}{\text{primary turns}} \text{ (in } \textit{calculations}\text{)}.$$

$R_p$ = ohmic resistance of primary coil.

(Suppose from previous calculation)

W = true watts absorbed by transformer when secondary circuit is unloaded.

$C_s$ = secondary current in amperes.

$R_s$ = „ ohmic resistance.

$E_s$ = „ terminal voltage when no load on secondary.

Percentage efficiency

$$= 100 \times \frac{\text{watts taken out}}{\text{watts put in}} = \frac{\text{watts in} - \text{watts lost}}{\text{watts put in}} \times 100$$

$$= \frac{C_s E_s + W - W - C_p{}^2 R_p - C_s{}^2 R_s}{C_s E_s + W}$$

$$= \frac{C_s E_s - C_p{}^2 R_p - C_s{}^2 R_s}{C_s E_s + W}$$

It is customary for the calculated efficiency to be *slightly* greater than measured efficiency.

A method I have used since 1893, with results very satisfactory, except for the fact that they differ considerably from those of the maker, is as follows:—

Measure the watts absorbed by the transformer when the primary coil only is connected up to the supply mains, suppose these watts to be w—this loss can be measured on either the high or low tension side—also note the secondary open circuit voltage, when primary volts are constant, suppose them to be $E_s$; suppose on remeasuring these secondary volts, when a current, $C_l$, is being taken from the secondary, we find them to be $E_l$ (primary volts being the same value as before) load to be non-inductive. Then the practical efficiency

$$= \frac{E_l C_l}{E_s C_l + W} \times 100.$$

You will notice that this considers voltage drop due to magnetic leakage as representing loss just as much as does drop due to C R; this assumption is to a very great extent true, and we must not forget it means a loss in revenue, owing to volts being reduced at terminals of lamps, even if not an actual transformer loss. I could weary you with tests made to compare this method with that of measuring watts supplied and watts withdrawn, the tests being made on a transformer showing a large percentage of secondary drop due to magnetic leakage.

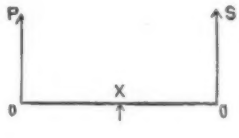
We have to consider the sources of loss in a transformer when energy is being taken from it. This loss includes energy absorbed in the iron core when no current is being taken out, and also the additional loss which results from taking energy away; it is with this additional loss that we will first deal.

There is naturally the loss resulting from resistance, of both primary and secondary coils, which increases as the square of the current, and which is also increased by the temperature to which the expended watts raise the copper.

In addition to this copper loss we have other copper loss in some transformers due to magnetic leakage, and further iron loss also due to magnetic leakage.

By magnetic leakage is meant:—That the lines of induction, or flux, produced by the primary or secondary coil, do not all cut through the secondary or primary coil; for instance, a transformer designed for maintaining constant potential difference between terminals of a secondary coil, will have a closed magnetic path provided for the reception of all flux produced by current circulating round the coils, so that all lines of induction produced by the primary coil, may, during their growth into the position they occupy when B reaches its maximum value, cut through the secondary coil so that $V_l \div T_l = V_p \div T_p$; if all the primary flux does *not* cut through the secondary coils, magnetic leakage is said to have taken place.

If an alternating current is passing through the secondary coil, a flux is being produced which has a periodic variation, exactly opposite to that of the primary current, and equal in strength to the additional flux in the primary; we have, then, as it were, two forces which may be represented diagrammatically thus:




O, P representing primary magnetomotive force.

O, S „ secondary „ „

Now, so long as these two equal and opposite forces exist in the same metal they will do no work, for if O P varies so does O S, and it is evident from the figure that no movement about the axis, X, can take place; since work is the product of force and displacement we cannot have work done on anything subjected to these forces; if, however, we reduce either of these forces or take one away entirely, we should immediately have work done, as we should have both force *and* displacement.

From this we can readily see that providing the flux due to primary and secondary currents exists in the same substance we cannot have increased loss, either eddy current or hysteresis, for, in the one case, induced electromotive forces, and in the other case, magnetomotive forces, balance each other; this is easily seen in the case of hysteresis by considering o o to represent a particle of iron ready to be influenced by magnetomotive force.

The above is intended to show how magnetic leakage will increase both hysteresis and eddy current losses.

The amount of magnetic leakage produced a M.M.F. ÷ reluctance of the path through which leakage of flux takes place.

It is apparent, therefore, that in order to reduce magnetic leakage we must so arrange the primary and secondary coils that no particular turn of one coil is far removed from the corresponding ones of the other coil, this is equivalent to sandwiching the coils as much as is found necessary, and to leave as small a distance between primary and secondary windings as is compatible with complete insulation of the coils, this is, of course, diminishing the section of the leakage path, increasing the length of the same will also increase the resistance offered by this path.

The current necessary to magnetise a transformer is in no way altered as the load is varied, *so long as magnetic leakage is not present*, but this current is increased by such leakage to an extent depending on the amount of leakage flux, the path through which leakage takes place together with the manner of leakage, by this I mean the density of the flux at the points it leaves the iron.

Owing to the additional insulation necessary, on and between coils and core of high tension transformers used in long distance transmission, we find such transformers show a much larger proportion of voltage drop due to magnetic leakage than do similar instruments designed for the same output but with lower electromotive forces.

There may be found some people who suppose drop (in volts) multiplied by secondary amperes must necessitate waste of energy, but although this supposition is erroneous, it is less so than to suppose that it does not mean any loss if the voltage drop be due to magnetic leakage.

Leakage, it will be seen, must cause a self-induced E.M.F. in the secondary coil and consequently expended watts are to be represented by the expression V A cos $\alpha$.

Looking at the general effects due to magnetic leakage, purely qualitatively we see that it—

(*a*) Produces loss in several ways.

(*b*) Causes the power factor of the primary to be lowered,

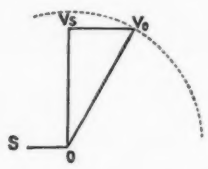
(*c*) Thus lowering the E.M.F. of the entire system of distribution and supply.

The reduction of voltage will possibly be most evident considered geometrically.

Suppose leakage to be present, we then have a secondary flux not

* This refers to shape of primary E.M.F. curve.

neutralised by the corresponding primary flux, and therefore an E.M.F. of self-induction is produced which we will call O, S, this E.M.F. will be ¼ phase behind the resultant E.M.F. represented by O, $V_s$, since the resultant E.M.F. produced the current whose surrounding flux is responsible for O, S; the values of O, S can easily be determined, for we know the measured values of O, $V_s$ and O, $V_o$ (the E.M.F. when no load is applied), and the relative positions of O, $V_s$ and O, S.




Draw a vertical line to represent O, $V_s$, and from $V_s$ draw a line, $V_s$, $V_o$, at right angles to O, $V_s$, and cutting a circle described with radius O, $V_o$ at the point $V_o$; from O, draw O, S, equal and parallel to $V_s$, $V_o$; this will represent the E.M.F. of self-induction in the secondary.

The voltage drop due to ohmic resistance of the coils, has been left out of consideration, in order to demonstrate that there *may* be a voltage drop due to magnetic leakage which does not necessarily represent expended energy.

From the above, it could easily be shown, with a similar figure, that the effective primary voltage will be similarly reduced.

Consider the primary and secondary coils arranged as in fig 1.

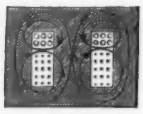


FIG. 1.

FIG. 2.

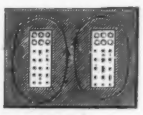


FIG. 3.

Then if we have a secondary current we shall have two M.M.Fs. opposing each other with the result that a leakage of both primary and secondary flux will pass across the air gap as shown. Obviously the way to avoid leakage is to make the iron circuit as easy a path as possible by increasing the section and diminishing the length, also by increasing the length and diminishing the section of all other paths which the lines of induction might follow.

From this we at once recognise the superiority of the arrangement of the coils in fig. 2 over that of fig. 1.

Fig. 3 represents the path occupied by the lines of induction when coils are arranged as in fig. 1, but no current is passing through the secondary, and therefore there is no opposing M.M.F. to that of the primary coil, the induction being of a much less value than in fig. 1, where the turns are the same but amperes increased, consequently we get increased hysteresis and Foucault current, immediately a secondary current is started in fig. 1 arrangement but not in an arrangement like that of fig. 2.

From this we see how utterly false would be the unqualified statement that the iron loss in a transformer does not vary with the energy being converted, *i.e.*, with the secondary load, the statement being true only where no magnetic leakage occurs.

Having briefly noted losses such as those due to ohmic resistance of coils, eddy currents in copper and other metals employed, which are of graver import when a transformer is loaded, we must pass on to the open circuit loss.

*(To be continued.)*

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

### NEW PATENTS.—1896.

12,481. "Improvements in bracket and chandelier arms for gas, oil, or electric light." S. EATON, H. EATON, and S. EATON, junr. Dated June 8th.

12,504. "Improvements in or in connection with the transmission and or transformation of electric currents specially applicable for lighting purposes." B. P. SCATTERGOOD. Dated June 8th.

12,531. "Improvements in switches for making and breaking electric currents." A. SLATTER and W. RIXON. Dated June 8th.

12,549. "Improvements in and in the manufacture of elements for secondary batteries." D. G. FITZGERALD. Dated June 8th.

12,550. "Improvements in electrical circuit-closing thermometers." A. LARASHI. Dated June 8th.

12,581. "Improvements in the method of supplying electricity to electrically propelled tramcars and other vehicles, and in apparatus therefor." P. J. PRINGLE and J. M. VERNON MONEY-KENT. Dated June 9th.

12,587. "Improvements in telescopic support for telephone transmitters." R. BAKER, J. FILMER, E. L. RYDER, and A. GARTNER. Dated June 9th.

12,588. "Improvements in telephone receivers." R. BAKER, J. FILMER, E. L. RYDER, and A. GARTNER. Dated June 9th.

12,611. "An improved cutter for covered wire." W. WILKINSON. Dated June 9th.

12,635. "Improvements in electrical switches." G. SENIOR, jun., and S. D. DUNDAS. Dated June 9th.

12,637. "Improvements in electric machines and in the method of operating the same." W. H. COOLEY. Dated June 9th.

12,650. "Improvements in thermo-electric generators." H. B. COX and the COX THERMO-ELECTRIC COMPANY, LIMITED. Dated June 9th.

12,738. "System for the indoor distribution of electric light." V. PLANQUES. Dated June 10th.

12,746. "Improvements in two pin plug for portable electric lamp." W. J. HEAD. Dated June 10th.

12,755. "An improvement in the manufacture and insulation of electrical conductors." THE TELEGRAPH MANUFACTURING COMPANY, LIMITED. Dated June 10th.

12,859. "Improvements in electric transformers." L. B. MILLER. Dated June 11th.

12,895. "Electric elevators." H. R. SMITH. Dated June 11th.

12,959. "Improvements in arc lamps specially applicable for lantern purposes." F. W. BRANSON. Dated June 12th.

12,983. "An improved grid or plate for secondary batteries." R. N. LUCAS. Dated June 12th.

13,023. "Improvements in casings for electric conductors." H. REASON. Dated June 12th.

13,046. "Improvements in and connected with cleats for electric and other wires and the like." F. B. EVANS. Dated June 13th.

13,048. "An electric lamp and oil can combined." J. RHODES and J. HENDERSON. Dated June 13th.

13,074. "Improvements in the manufacture of electrical resistances." A. J. MARQUAND and D. LOWDEN. Dated June 13th.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* *(in stamps.)*]

#### 1895.

5,205. "Process for the production of electrode plates for secondary batteries." C. LUCKOW. Dated March 12th, 1895. A process for the production of electrode plates for secondary batteries, according to which bright plates of lead are subjected to a preparatory treatment in special vessels before the building up of the secondary cells, the treatment being distinguished by the application as electrolyte of strongly diluted, slightly acid, neutral or weak, alkaline solution of fixed percentages of some special salts which are described. 1 claim.

9,380. "Improvements in electrical firing pistols for gun mountings." E. W. LLOYD. Dated May 11th, 1895. The firing key is composed of a hollow casing of pistol form, a movable block closing an opening on the underside of the forward part of this casing. The insulated conductors and contact mechanism are secured to it, and a trigger is provided for closing the contact mechanism. 2 claims.

9,504. "Improvements in shades or reflectors for incandescent electric and other lamps." A. A. BAWETT and THE ARTISTIC LETTER COMPANY. Dated May 14th, 1895. The shades or reflectors of incandescent lamps are formed of celluloid instead of the opal commonly used. 1 claim.

10,029. "Improvements in pendants or electroliers for electric lamps." J. W. SINGER, W. H. SINGER, and E. R. SINGER. Dated May 21st, 1895. The usual tube or barrel is dispensed with, a chain being provided, each link having two holes, so that when the chain is made up the conductors may be threaded through an axial hole running the entire length of the chain. 5 claims.

10,792. "Improvements in dry galvanic batteries." W. ELLIOTT. Dated May 31st, 1895. A case of wood, ebonite, or other insulating material rendered airtight, is lined with a zinc plate to which is affixed a terminal. A packing of cocoanut fibre soaked in a saturated solution of salammoniac and squeezed as dry as possible is packed tightly in the zinc lined cell, a space being left in the centre to admit a carbon plate packed on either side with powdered carbon and manganese. The cell is then sealed. 1 claim.

21,460. "Improvements in electric controllers and reversing switches for electric motors." W. H. MORGAN. Dated November 12th, 1895. A very complicated specification dealing with several novel features of construction and arrangements of parts of switches and controllers for electric motors." 21 claims.

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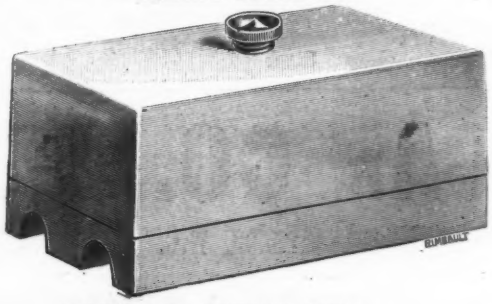

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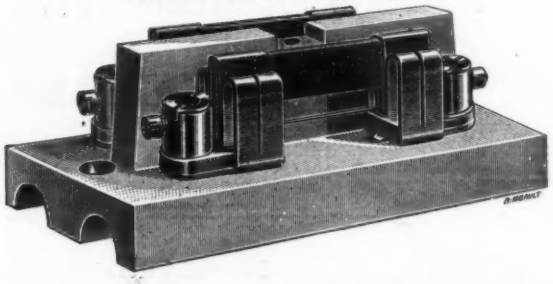

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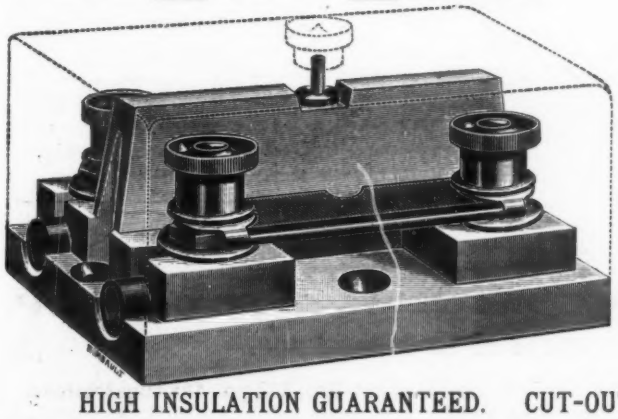

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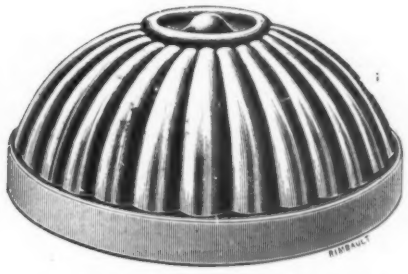

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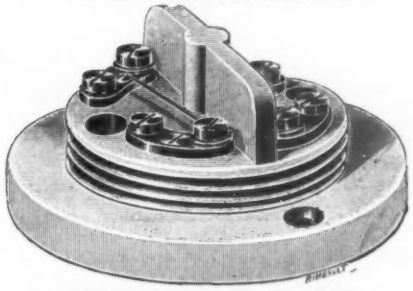

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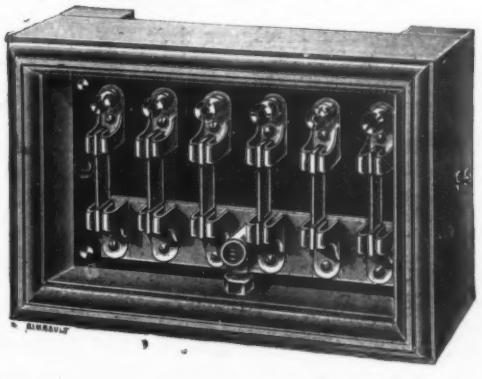

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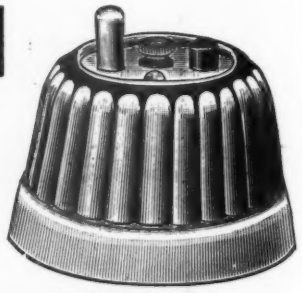

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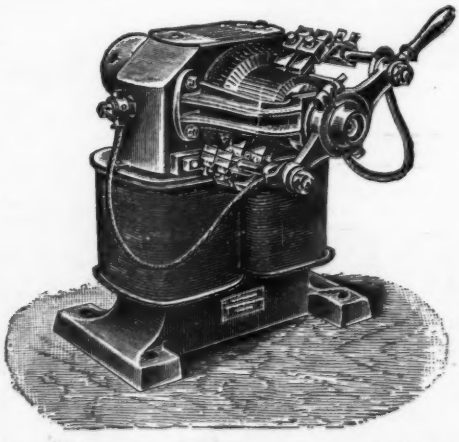

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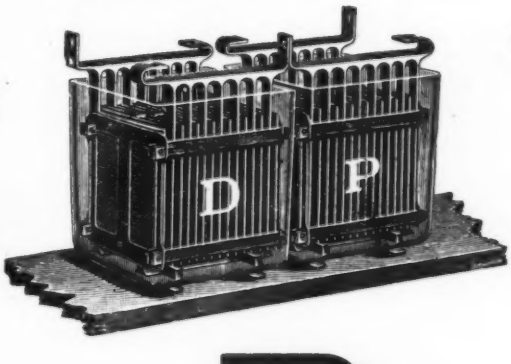


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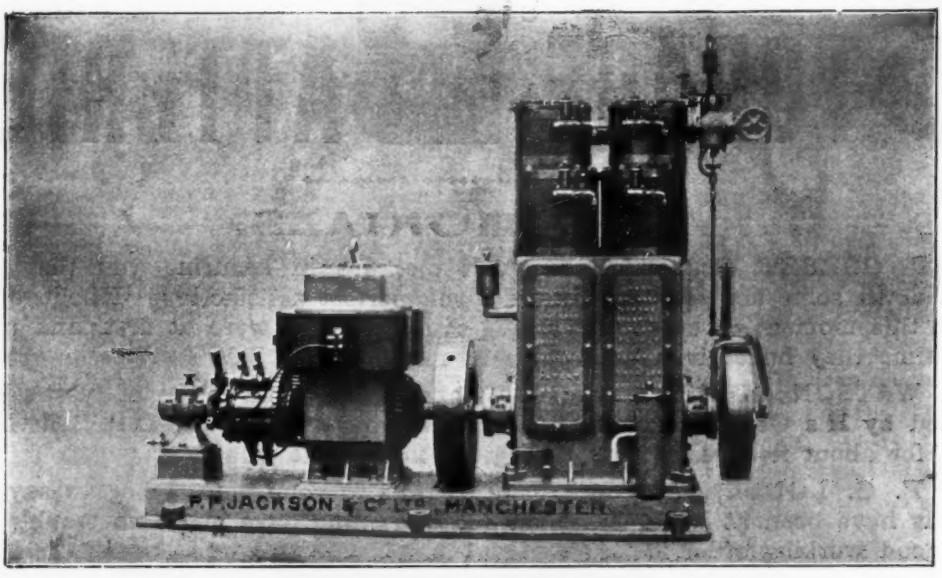


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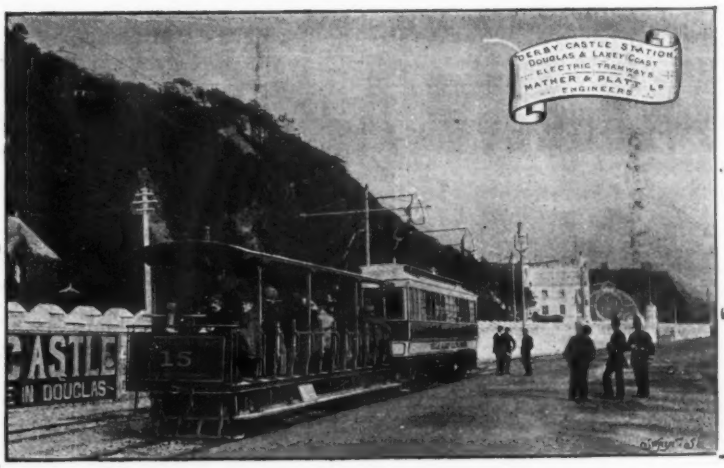


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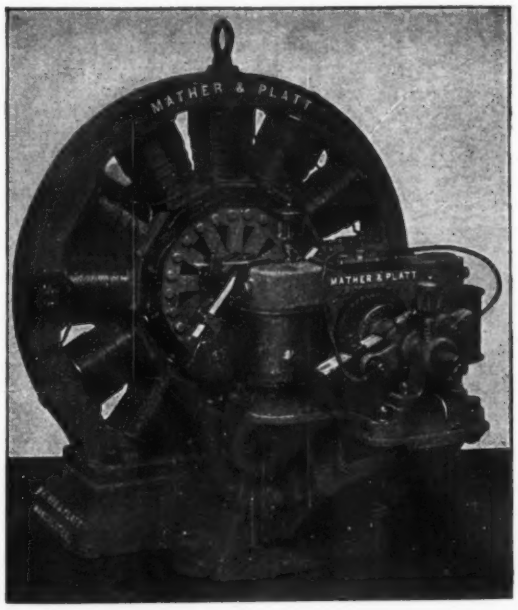


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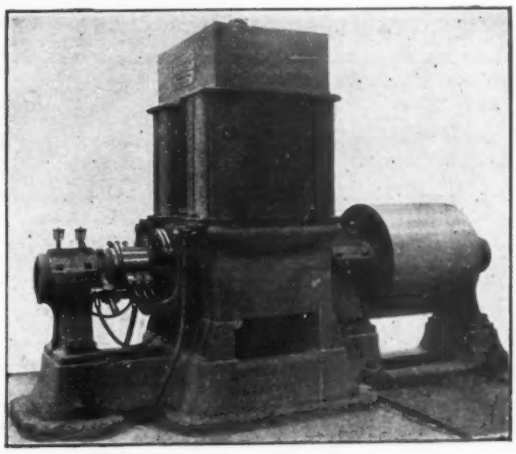

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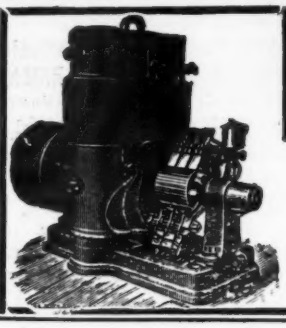

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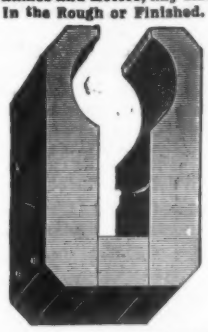

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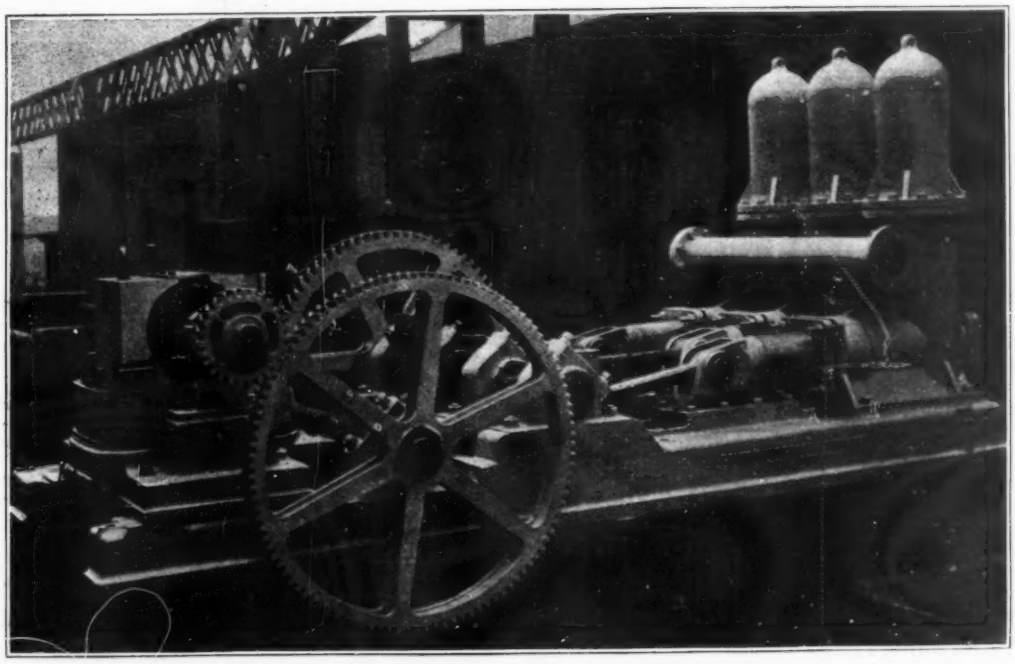

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THE Courses of Instruction in ENGINEERING and CHEMISTRY at the Institute's Colleges commence in OCTOBER, and cover a period of two to three years. The MATRICULATION EXAMINATION of the **Central Technical College** will be held on SEPTEMBER 21st to 24th, and the ENTRANCE EXAMINATION of the Day Department of the **Technical College, Finsbury,** on SEPTEMBER 22nd.

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*Professors.*—S. P. Thompson, D.Sc., F.R.S. (Electrical Engineering), R. Meldola, F.R.S. (Chemistry).

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MESSRS. LEAROYD BROS. & CO. are prepared to receive tenders for the Wiring of the above Mills. Copies of the specifications and general conditions may be obtained from Messrs. SHEPHERD & WATNEY, 71, Albion Street, Leeds, after the 22nd, on receipt of a cheque for one guinea, which will be returned on receipt of a *bonâ fide* tender. Tenders, endorsed "Electric Lighting," must be addressed and delivered to Messrs. LEAROYD BROS. & Co., Milnsbridge, Huddersfield, before noon Tuesday, July 7th. 10 x 2

### WALLASEY URBAN DISTRICT COUNCIL.

#### TO ENGINEERS AND OTHERS.

THE WALLASEY URBAN DISTRICT COUNCIL are prepared to receive tenders for Condensing Apparatus, and Steam and Exhaust Pipes, in connection with their electric light installation.

Drawings may be seen, and copy of the specification obtained, on application to the Engineer, Mr. J. H. CROWTHER, at the Gas and Water Works, Great Float, near Birkenhead. A charge of £2 2s. will be made for each copy of the specification, to be returned on receipt of a *bona fide* tender.

Sealed tenders on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Condensing Apparatus, &c.," to be delivered at my office, as below, not later than 4 o'clock in the afternoon of THURSDAY, JULY 16th, 1896.

The contractor will be required to enter into a bond, with approved sureties, for the due performance of the contract.

The Council do not bind themselves to accept the lowest or any tender.

By Order,
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Applications, accompanied by three recent testimonials, to be sent to me at the Town Hall, Brighton, before 10 a.m. on TUESDAY, JULY 7th, 1896.

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### THE VESTRY OF THE PARISH OF ST. MARY, BATTERSEA.

#### ELECTRIC LIGHTING.

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Persons tendering are at liberty to tender for either section, but not for part of a section.

The ground plan of plant, and specification, with terms and conditions of Tenders and Contract, may be obtained at the offices of Mr. ROBERT HAMMOND, the Consulting Engineer to the Vestry, Ormond House, Great Trinity Lane, London, E.C., on and after Monday, the 29th June, upon production of a receipt for £3 3s., signed by the Vestry Clerk, which sum will be returned after receipt of a *bona fide* Tender.

Tenders sealed and marked "Tender for Electric lighting," must be addressed to the undersigned, and delivered at the Municipal Buildings, Lavender Hill, S.W., on or before Tuesday, the 14th July, at 12 o'clock noon, and no Tender will be considered unless the same be made on the official form.

The Contract will be prepared by and at the expense of the Vestry.

Persons tendering will be required to declare in their Tender that they pay the Trade Union rate of wages, &c., and must append to the Tender a schedule of the wages paid to the various classes of workmen employed by them at the time of tendering.

The Vestry do not bind themselves to accept the lowest or any Tender.

By Order of the Vestry of the Parish of St. Mary, Battersea,
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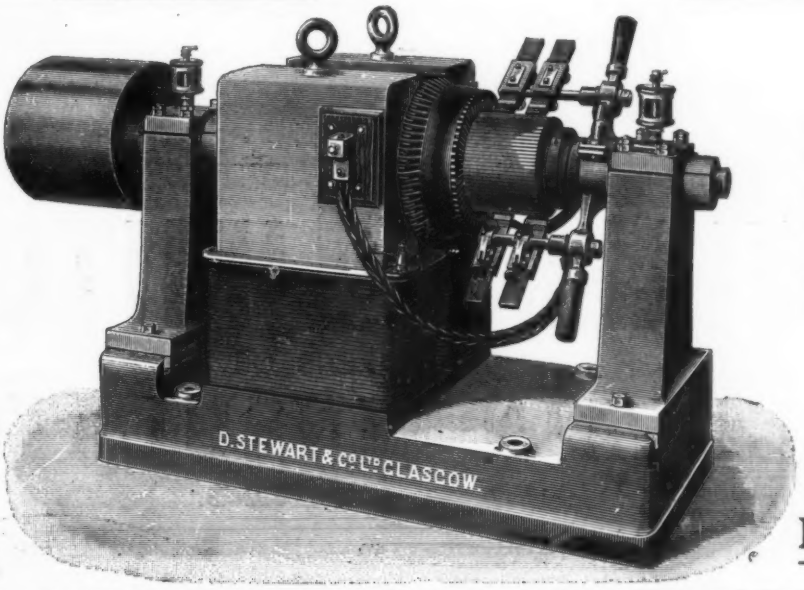


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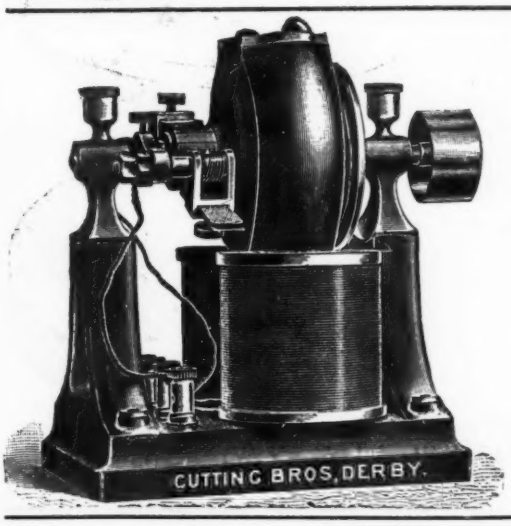


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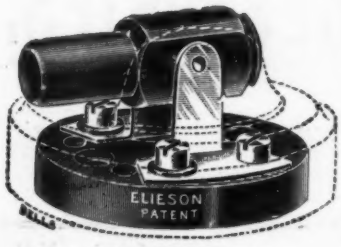


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1042

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*Clerk to the Council.*

Public Offices,
Egremont, Cheshire,
*June 11th*, 1896

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F. J. TILLSTONE, *Town Clerk.*

*June 22nd*, 1896.

10006

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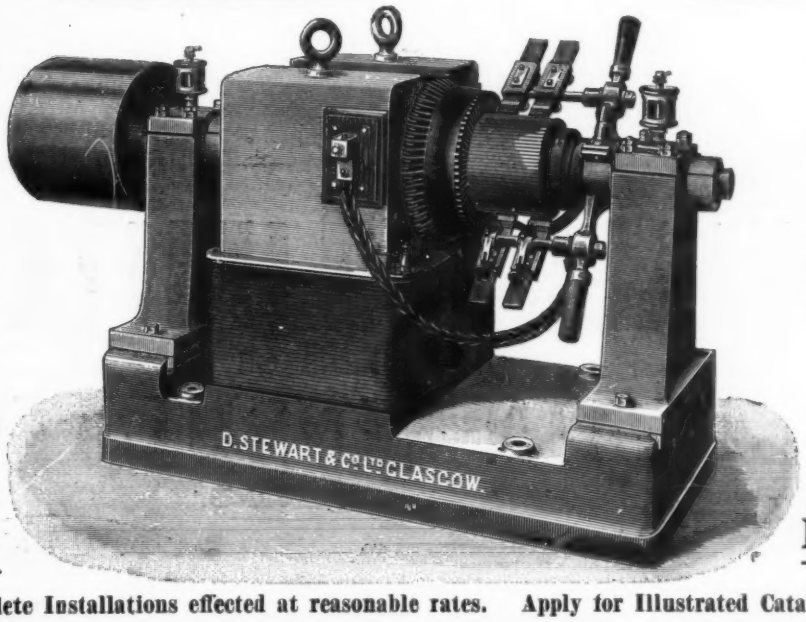


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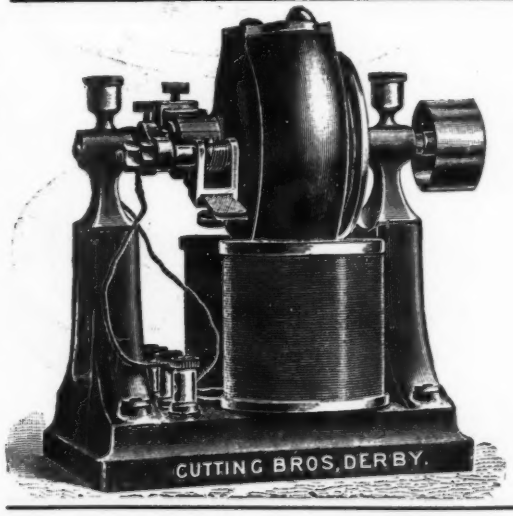


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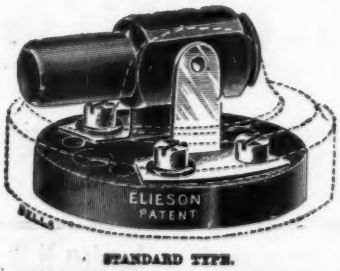


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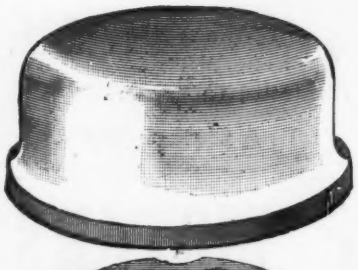

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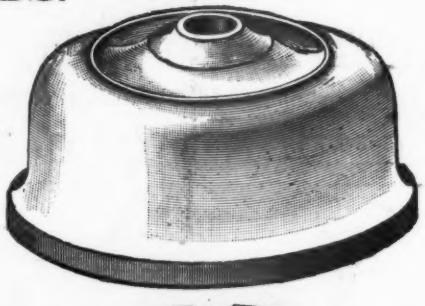

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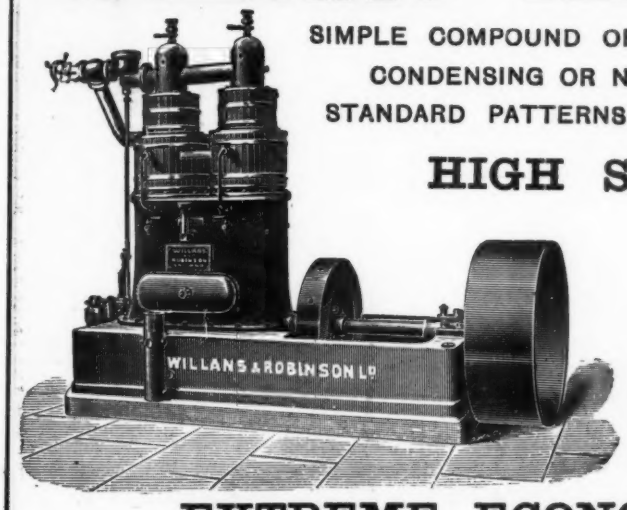


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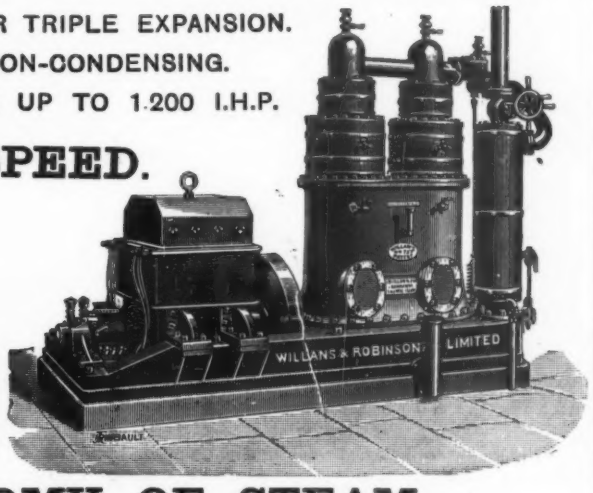


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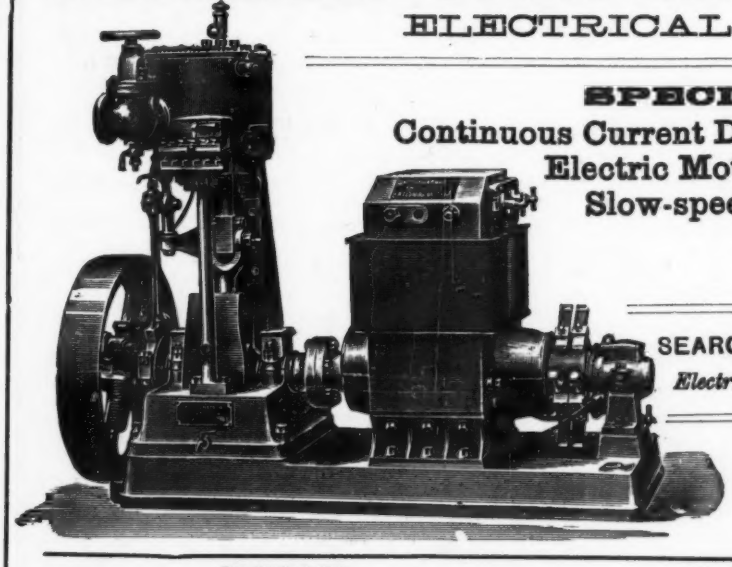

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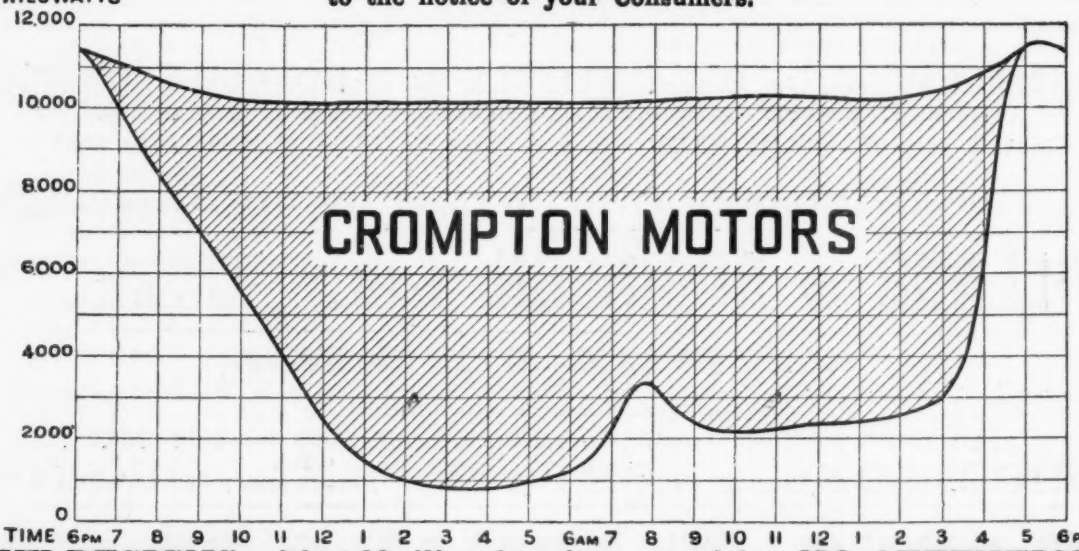


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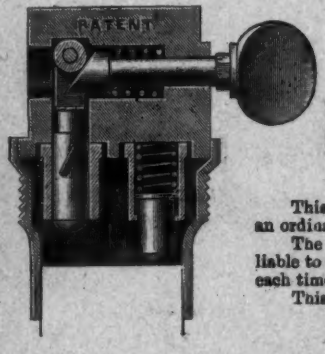


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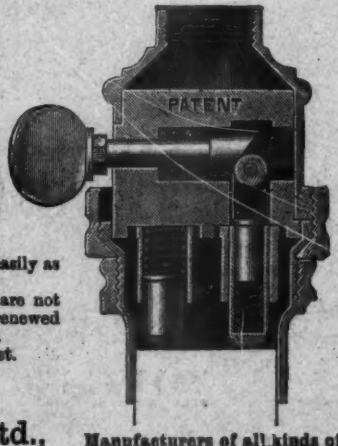


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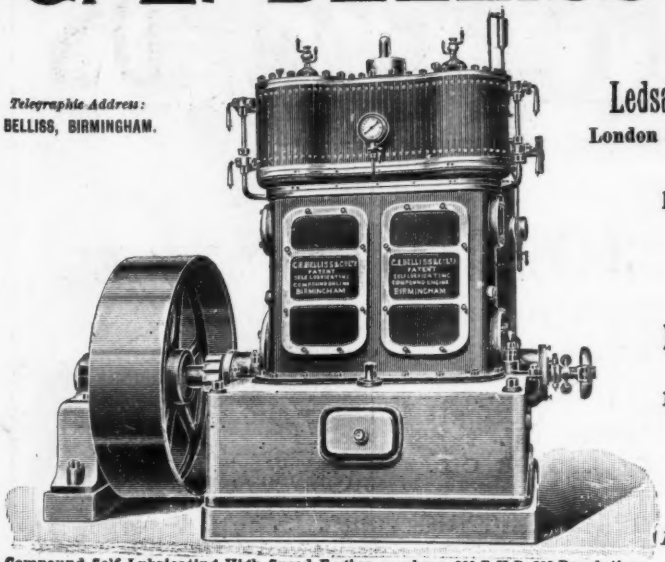

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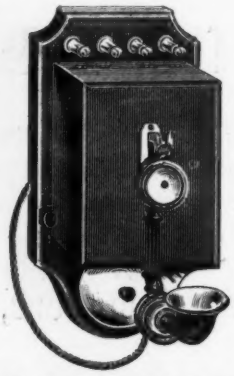

Fig. 387.—Wall Instrument, with Movable Microphone and Receiver combined, Price 36/- each.

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N.B.—Fig 388 can be supplied with interchangeable switch to work in conjunction with the switches on Fig. 433 instruments for extra cost of 15/-. Fig. 433 can be supplied with Microphone and Receiver combined as Fig. 387, for 15/- extra. 8136

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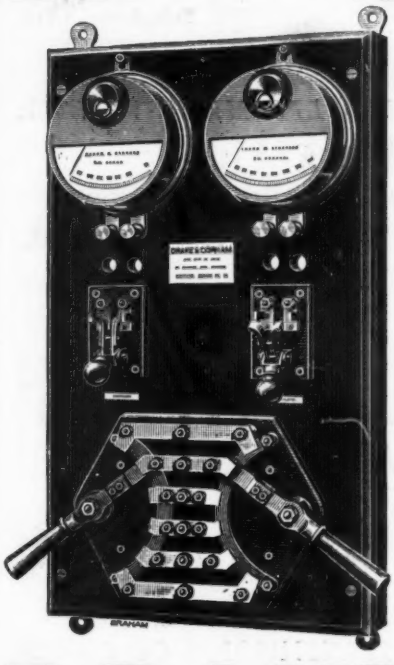

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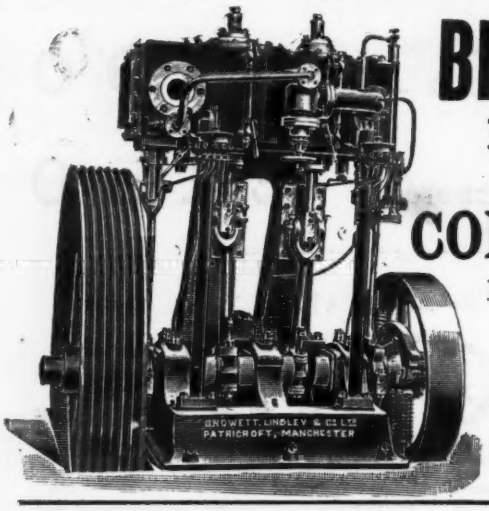


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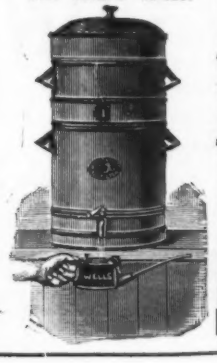

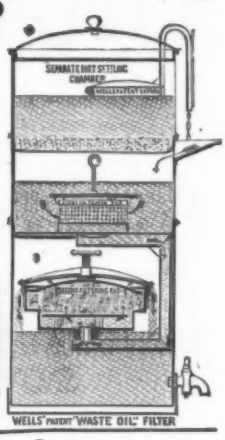


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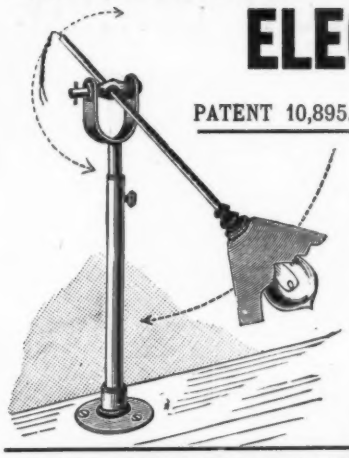

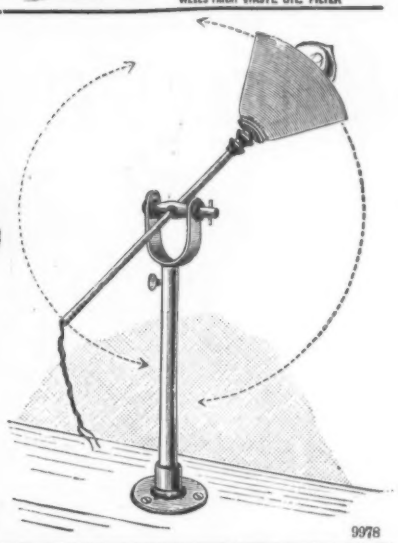

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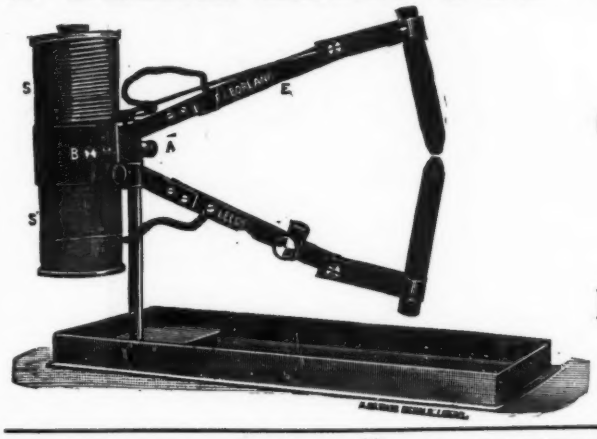

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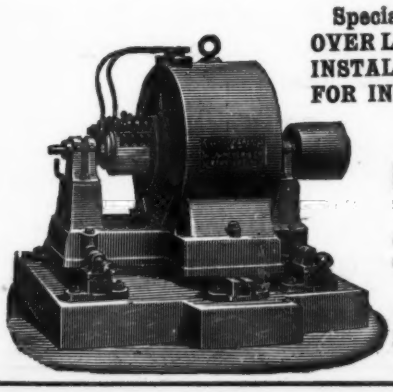

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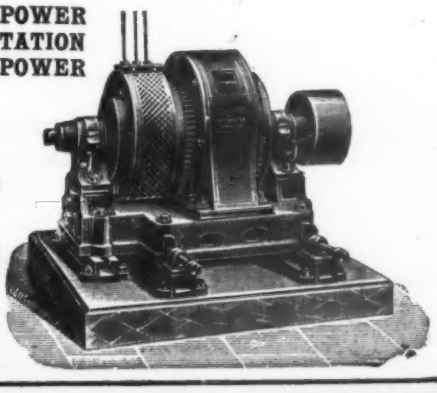

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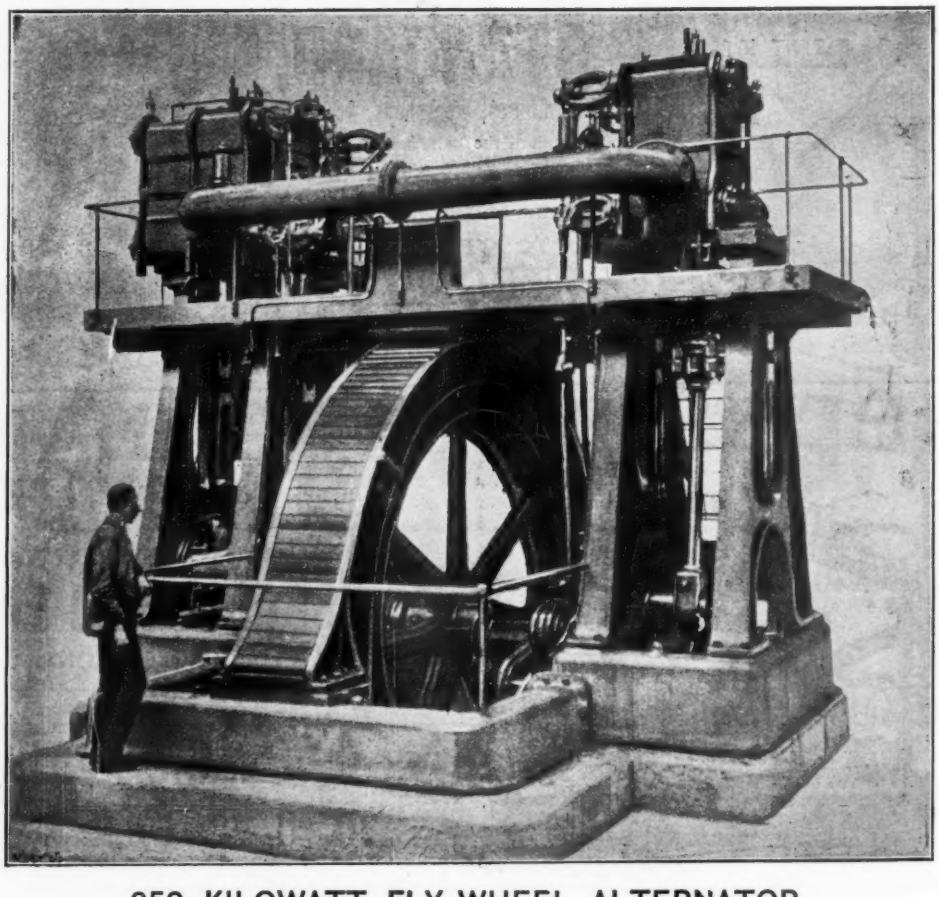

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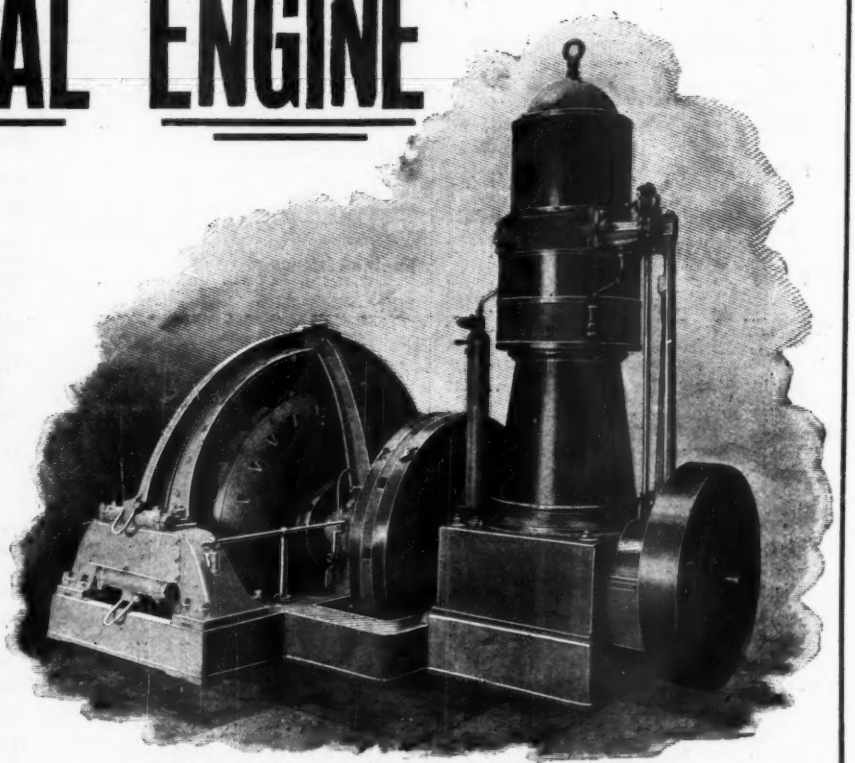

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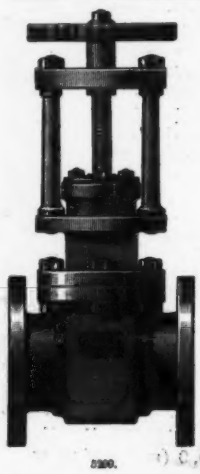

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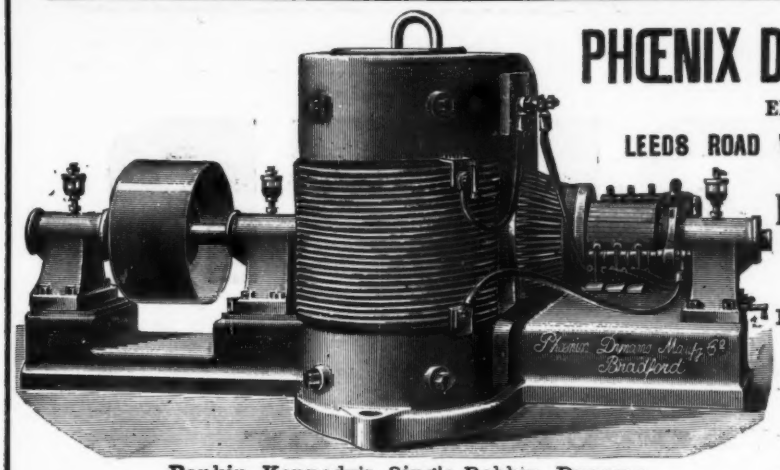


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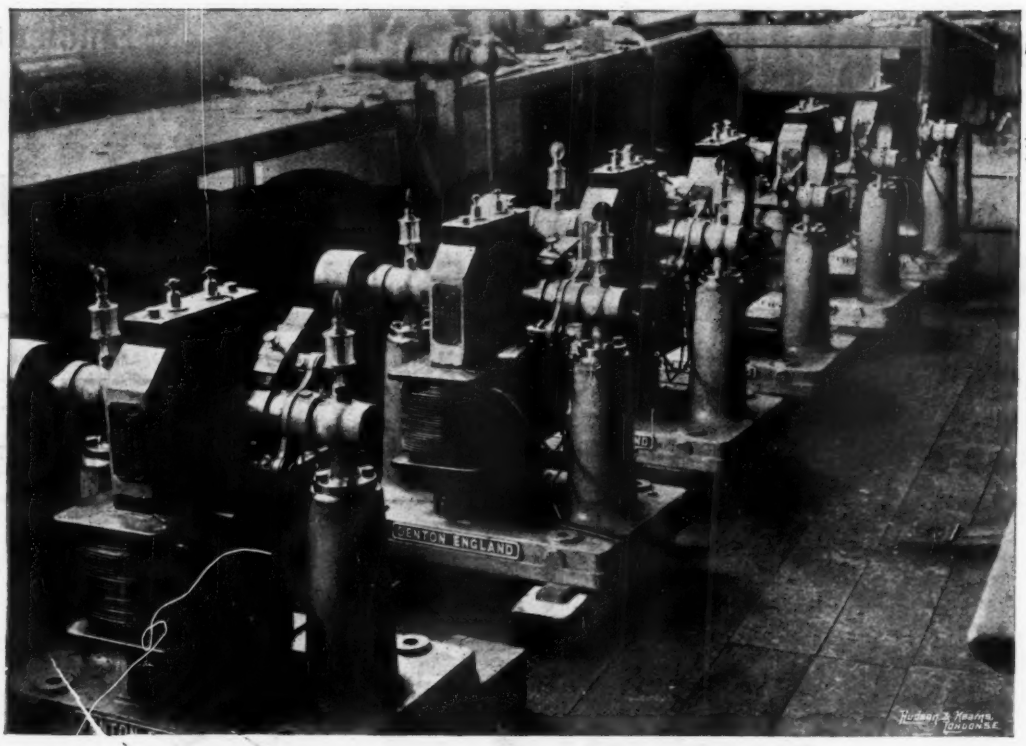


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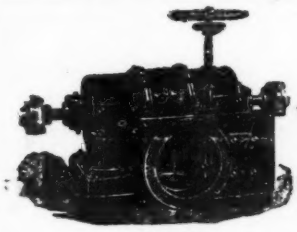

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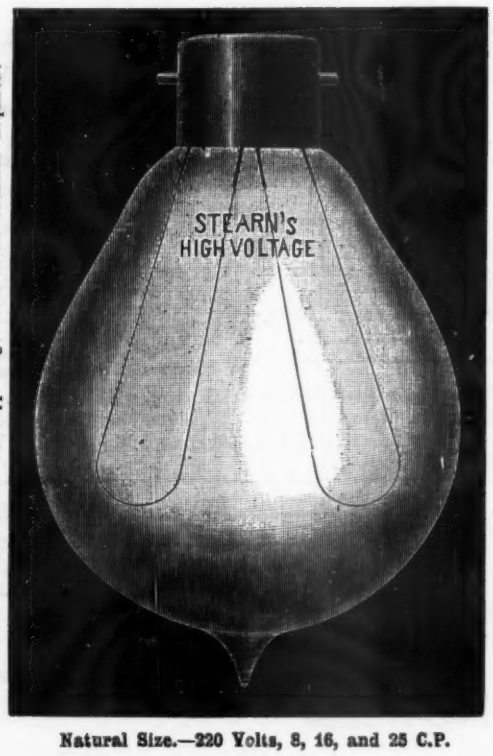


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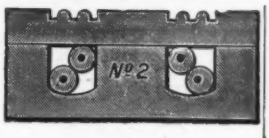


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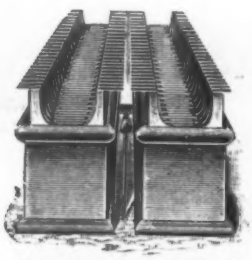

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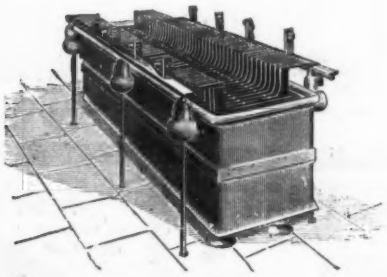

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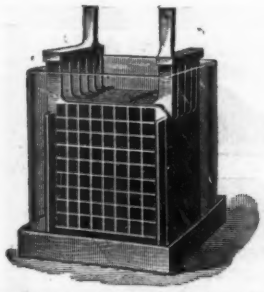

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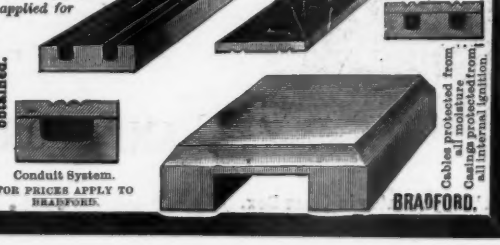

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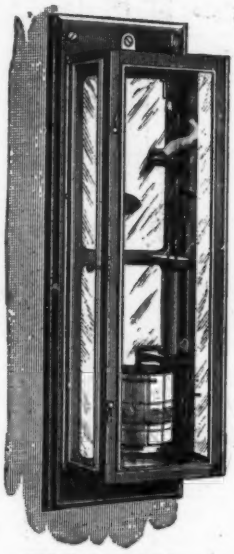

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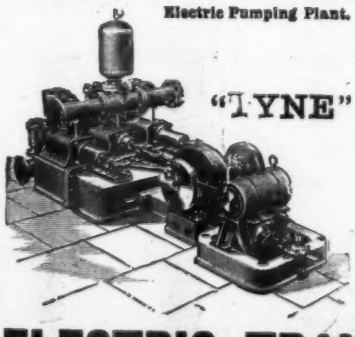

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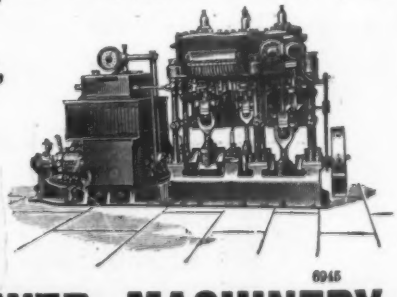

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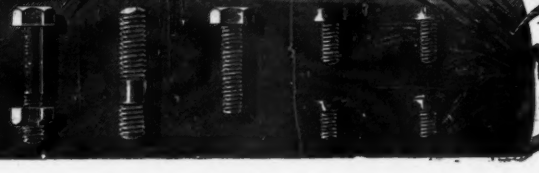

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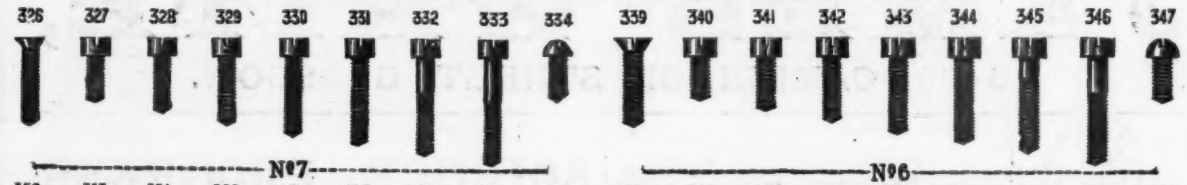


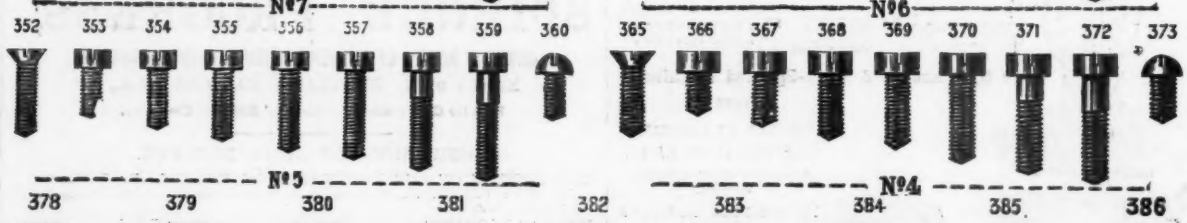

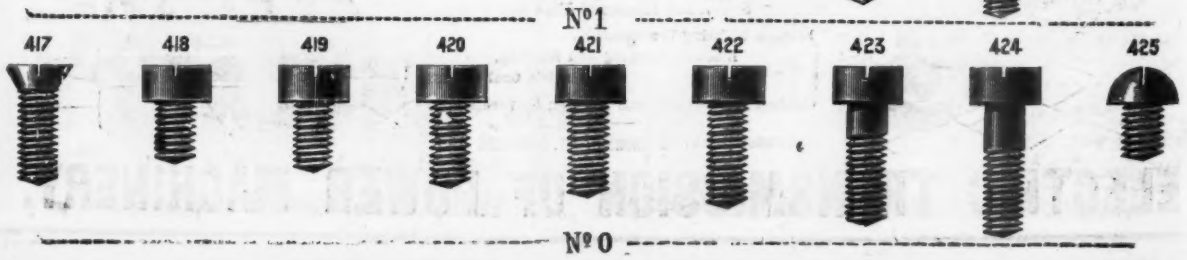

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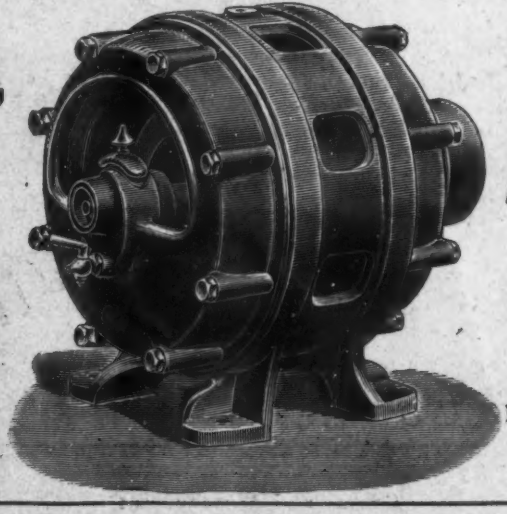

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